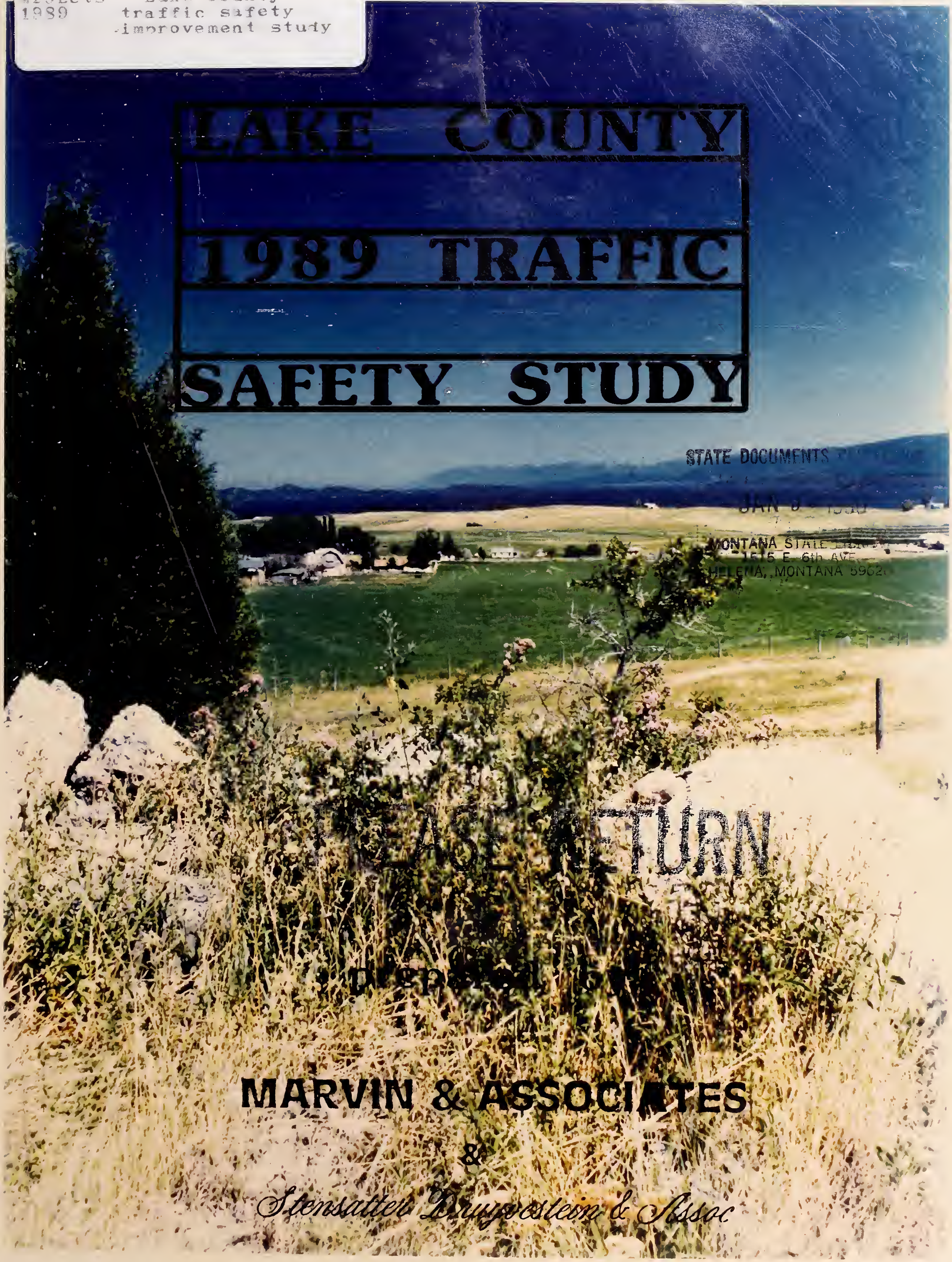
LAKE COUNTY
1989 TRAFFIC
SAFETY STUDY
STATE DOCUMENTS
MONTANA STATE
1515 E. 6th AVE.
HELENA, MONTANA
PLEASE RETURN
prepared by
MARVIN & ASSOCIATES
&
Stensatter Bruggeman & Assoc

LAKE COUNTY

TRAFFIC SAFETY IMPROVEMENT

STUDY

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SEPTEMBER 1989

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INTRODUCTION

STUDY PURPOSE

Lake County, in an effort to reduce or otherwise alleviate problems at accident cluster sites on the County Road System, has retained the Consulting Engineering Firm of Marvin & Associates to perform a traffic engineering study. The purpose of this study is to identify accident cluster locations, collect and analyze pertinent data, make short and long term safety improvement recommendations and establish a priority list of improvement projects.

Other similar studies have been completed for Montana counties with the technical and fiscal assistance of the Montana Department of Justice, Highway Traffic Safety Division. The intent of the Highway Traffic Safety Division in sponsoring these studies is to first, reduce accidents on the county road systems and secondly, to establish an awareness of accident reduction measures so that a continuation of the program can be established within each county.

The methodology used in these studies, which primarily served as the basis for the analysis within this report, can be found in the report No. FHWA-RD-77-83 "Identification of Hazardous Locations. Refinements to the FHWA report made by DCA Project No. 79-04-01-01 and subsequent county studies throughout the state, are also incorporated within this report. The methodology used to establish priority rankings is explained in the Benefit/Cost Ratio section of this report and is tailored specifically to Lake County's unique requirements.

The implementation of traffic safety improvements contained within this report is presented differently than in some previous studies. Since the Montana Department of Highways (MDOH) has Off-system Safety funds available for use on some or all of the improvement projects recommended herein, the priorities and funding obligations are specifically tailored to MDOH requirements. Upon approval of this program by the county commission, this report should be submitted to the Department of Highways as justification for Off-system Safety fund allotments.

REPORT ORGANIZATION

The initial section of this report contains narratives describing the accident cluster site locations, characteristics of the county road system, study methodology, results of the hazard index analysis for all of the sites, explanation of the improvements recommended, priority index calculations, an implementation schedule and recommendations for continuation of the program in future years. **Special attention should be given to the Site Characteristics and Explanation of Improvements sections. Specific traffic safety information for the Lake County road system is presented in these sections.**

Site specific data can be found within the individual site sections following the main body of this report. A great deal of computer generated data was printed and reduced for inclusion on the existing condition and short term improvement sketches. The availability of pertinent data on the same page as the sketches

hopefully aids in comprehension of the problem identification and improvement benefits. The short term plan sketches can also be used by the Department of Highways to verify the traffic control device items eligible for funding through their program.

The site specific sections of this report are numbered according to their priority ranking as indicated in the site location section of this report. Only 10 sites are included in this project due to budget restrictions. Some of the sites were extensive in length and encompassed several localized cluster sites within them. For these particular sites, the recommendations are tied to improving individual sections with safety of the entire corridor in mind.

The basic organizational format of the site specific sections is as follows:

Narratives
* Location Description
* Existing Conditions
  - Geometrics
  - Traffic Control Devices
  - Traffic Volumes
  - Traffic Operations
  - Accidents
* Short & Long Term Improvements
* Benefits

Figures
~ Photos
~ Existing Condition Sketch
~ Short Term Improvement Sketch

SITE CHARACTERISTICS

SITE LOCATIONS

The maps contained at the end of this section (Figures 1.) show the ten accident sites and corridor areas respective to their priority numbers. Table 1., below, is a listing of site numbers corresponding to the site locations:

TABLE 1. LIST OF STUDY SITES

SITE PRIORITY I.D. NO.	LOCATION
1	ST. MARY'S ROAD
2	OLD U.S. 93 - CANYON MILL
3	TIMBERLANE ROAD @ 1.0 MILES
4	TIMBERLANE ROAD @ 2.5 MILES
5	TERRACE LAKE ROAD
6	ROUND BUTTE ROAD
7	TURTLE LAKE ROAD
8	OLD U.S. 93 CURVE S. OF PABLO
9	ROCKY POINT ROAD
10	FINLEY POINT ROAD

SYSTEM CHARACTERISTICS

Traffic Volumes - All of the accident sites are located in a rural environment and are on low volume roads. The highest traffic volume at any site is approximately 1,800 vehicles per day while the lowest volume is 150 vehicles per day.

Bob Smith, of the Lake County Road Department, provided information on some of the historical aspects of the roads within the county and for various conditions at these sites. It should be noted that the County Road Department has not collected traffic

data for Lake County roads in the past. The County should consider initiating a counting program in the future. Traffic volume records would not only aid in the continuation of a safety program, but it would assist the county in establishing a priority system for future maintenance and construction programs.

From records provided by the Montana Department of Highways, it appears that traffic volumes have been increasing at a 2-3% annual rate on some of the county roads. MDOH counts were recorded on machine counters. These counts were used to determine hourly traffic variations on various types of roads in Lake County. The hourly counts used in this study were graphed as a percentage of average daily traffic verses hour of the day. Additional machine counts were taken during the course of this study to determine ADT and to develop a typical range of hourly variations to be used in estimating average daily traffic. Figure 2. is composed of three graphs of hourly traffic variations for Round Butte Road, FAS 211 -Terrace Lake Road and Old U.S. 93 at Canyon Mill Road.

While evaluating the shape and peaking characteristics of the traffic volume curves, it was noted that two of these roads are typical of most rural or urban roads. The Old U.S. 93 counts exhibited some very unusual peak volume characteristics. Therefore hourly variations from that site were not used to estimate ADT's at other sites.

Roadway Characteristics - The Lake County Road System is composed of roads typical to rural western Montana. Most of the roads are paved within a certain distance of population centers, while gravel

roads are found in the foothills and mountains where residential and farming land uses are sparse. The County's major transportation needs are served by U.S. Route 93 which runs north-south from one end of the county to the other. Since the Mission Mountain Range parallels U.S. 93 and the major population lies west of the mountains, Highway 83 (east of the mountains) is not as critical to Lake County's transportation system. Other routes parallel to U.S. 93 are limited in length and therefore do not serve as arterial roads.

Lake County's road system encompasses an extensive length of roadway. There are roads along almost every section line within the valley areas. Maintenance of this extensive system is an incredible financial burden when the limitation of funds are considered. Maintenance of the road surface and critical roadway features are usually all that can be programmed on a year to year basis. Yet, road surfaces have become deteriorated and have contributed to accidents on the county road system. In all but four of the study sites, the roadway surface condition had some involvement with accident experience. All of the gravel surface roads had at least one accident directly attributable to washboard conditions. Some of the paved roads also have ruts or raveled surfaces which tend to cause problems with vehicle dynamics and present unexpected manuevering situations for drivers.

Another of the most common problems observed at the study sites, involved condition of the roadside environment ie. sight distance restrictions caused by trees and brush or by machinery and buildings in the sight triangle. Trees should be trimmed at least

10 feet above the roadway and bushes should not exceed 3 feet in height to provide an unobstructed line of sight. In the forested section of roadway, clearing of trees is impractical, but critical obstructions could still be removed without a massive effort. Proper sight distance requirements for each situation can be found in the 1985 AASHTO publication "Policy on Geometric Design for Highways and Streets", also known as the Green Book.

Study Applications -From past experience, it has been discovered that the methods utilized in these type of studies provide quite different results when applied to an urban area as opposed to rural country roads. In this case, the application of study methods is ideally suited to the rural road system in Lake County. Even though all of the roads are rural in nature, the highest priority sites were on the lowest volume sections of roadway. This situation should be expected, since cluster sites on low volume roads have a higher accident rate; speeds are higher and thus severity is usually greater; and the cost of making significant improvements is usually less. Since the site selection process for this study was based on statistical indicators based on these factors, the lowest volume rural roads usually ranked high.

Traffic Control Devices - Some degree of traffic control devices were present at the majority of the sites. However, none of the sites had control devices that were completely adequate for the conditions encountered. Some sites were signed for one particular hazard while completely ignoring other (perhaps more important)

conditions of the site. In one instance, the signing was found to be a potentially contributory factor in accident occurrence. The positioning of speed limit signs adjacent to, and in advance of, curve warning signs, makes it appear that the curve can be traversed at a speed 15 mph faster than what is reasonable. These speed limit signs are on Timberlane Road and should be relocated or removed as soon as possible to avoid further misinformation.

The sites, for the most part, were typical of all Lake County roads, as far as the application of traffic control devices. Warning and guide signs are used sparingly or not at all on most of the road system. Pavement markings, along with roadside delineation, are all but nonexistent on county roads. In some areas, signing is applied conservatively while others have no signing. This is understandable, considering the limited budget of county governments. However, this study recommends a high degree of signing and pavement marking application at the study sites. Since consistency of signing and pavement marking is extremely important, Lake County should plan on revising the applications and locations of signs and pavement markings on all county roads after these improvements are implemented. Since the needs are great and the funds are limited, this work should be considered a long range goal of the county. Standard traffic control devices applied consistently will aid in the future elimination of accidents county wide.

Traffic Accidents - Traffic accident characteristics for all of the Lake County sites are summarized below:

ACCIDENT STATISTICS - ALL LAKE COUNTY SITES

ACCIDENTS / YEAR :				ROAD CONDITIONS - % OF TOTAL :	
1985 = 23			51	DRY =	63%
1986 = 16			7	WET =	9%
1987 = 15			23	ICY =	28%
1988 = 27 TOTAL = 81				LIGHT CONDITIONS - % OF TOTAL :	
ACCIDENT TYPE - % OF TOTAL :			41	DARK =	51%
3	HEAD ON =	4%	40	DAY =	49%
7	ANGLE =	9%			
1	LEFT TURN=	1%		SEVERITY - % OF TOTAL :	
3	SIDE SWP.=	4%	2	FATAL =	2%
2	REAR END =	2%	35	INJURY =	43%
61	SINGLE V =	75%	44	PROP DAM=	54%
4	OTHER =	5%			
WEATHER CONDITIONS - % OF TOTAL :				ALCOHOL	30
67	CLEAR =	83%		INVOLVED	
5	RAIN =	6%		% TOTAL =	37%
8	SNOW =	10%			
1	FOG =	1%			

Of all the years in this period, 1986 and 1987 had the least number of accidents. The predominance of rural sites is evident since they are primarily single vehicle accidents. Most of the accidents occurred in clear weather on dry roads. Night time accidents were more common than daytime accidents and property damage accidents outweighed injury accidents. Two fatal accidents occurred within the study sites. Alcohol involvement played only a minor role, since only 37% of the accidents involved drivers who had been drinking.

Future System Characteristics - Lake County does not have a formal transportation plan. It can be assumed, from conversations with MDOH and County officials, that Lake County is rather sporadic in growth. The existing economy is not the best it has ever been and rapid growth will not be a significant problem in the near future. Since the exact rate and areas of growth, along with any resultant impacts, at the study sites are not known, long term improvements suggested within this report are based solely on existing traffic conditions. Long term solution are merely alternative improvements involving a higher level of safety with a commensurate degree of funding requirements.

STUDY METHODOLOGY

The study was segregated into four distinct phases which best achieved the purpose and scope of the traffic study. These phases are outlined as follows:

Phase 1 - Site Selection Phase; involved copying all of the accident reports on Lake County roads for the years 1985 thru 1988 from Department of Justice files in Helena, Montana. These reports were first arranged alphabetically and separated according to road names. Reports on each individual road were screened for location by intersecting roadway and cross referenced. Finally, the reports were plotted on county grid maps to identify cluster areas. All identified clusters having less than three accidents during the

reporting period were discarded. The remaining accidents were entered into a computer program to calculate preliminary hazard index values.

Number of accidents, accident rates and severity indexes were calculated for thirty two cluster sites. Table 2. is a summary of the screening program. The cluster sites were ranked according to the composite value of the three indexes. A recommended list of sites was sent to Lake County for their approval. The list was modified due to overlapping jurisdiction and other valid reasons and the final list of sites was approved.

Phase 2 -Data Collection Phase; included the preliminary organization of the project including scheduling, site location, form processing, field data collection and reduction of data. Accident data was obtained from reports provided by the Department of Justice. Traffic counts were taken at each location. The existing average daily traffic was determined by applying factors for hourly, daily and monthly variations. Historical traffic volumes were provided by MDOH where available.

Other data collected in the field included measurement of road widths and geometrics, and inventory of traffic control devices, turning movement counts and subjective observation of traffic operations. Aerial photographs were used to develop horizontal alignment.

TABLE 2. LAKE COUNTY ACCIDENT CLUSTER SITE SELECTION MATRIX - PRELIMINARY

SITE NO.	MAJOR ROUTE	INTERSECTION OR LOCATION	ACCIDENTS / YEAR 85	86	87	88	TOTAL NO. ACC.	NO. ACC. INDEX	APPROX. VOLUME	ACC. RATE	ACC. RATE INDEX	SVRTY INDEX	COMPOSITE SCREEN INDEX	REMARKS
1	TURTLE LAKE ROAD	TURTLE L TO.7 MI N	6	2	3	1	12	72	1000	8.22	109	33	73.6	RECOMMENDED SITE
2	ST MARYS ROAD	4.5 MI SE ST IGNAT	1	3	0	4	8	61	800	6.85	99	45	70.5	" "
3	KINGS POINT ROAD	.5 MILE AT END	2	3	0	0	5	50	400	8.56	112	35	68.9	" "
4	TERRACE LAKE ROAD	.5-2 MI E US 93	5	4	1	7	17	81	2000	3.88	69	38	62.1	" "
5	CANYON MILL RD	JUNCT OLD US 93	1	3	3	1	8	61	2000	2.74	53	61	57.9	" "
6	ROCKY POINT ROAD	1.5-2.0 MI N US 93	2	2	2	3	9	64	1800	3.42	63	43	56.8	" "
7	TIMBERLANE ROAD	CURVE 2.5 MI E 93	3	1	1	0	5	50	800	4.28	74	40	55.9	" "
8	TIMBERLANE ROAD	.5-1 MI E US 93	1	0	1	3	5	50	1000	3.42	63	53	55.9	" "
9	TIMBERLANE ROAD	CRV I MI S TERRACE	1	0	1	2	4	45	700	3.91	69	45	54.6	" "
10	OLD US 93	CURVE 1.2 MI S PAB	4	0	1	3	8	61	1600	3.42	63	37	53.7	" "
11	ROCKY POINT ROAD	US 93 TO 1 MI N	3	3	1	0	7	58	1600	3.00	57	43	52.6	ALTERNATIVE SITE
12	MISSION DAM ROAD	1.4 MI E US 93	2	1	1	0	4	45	900	3.04	58	51	52.2	" "
13	KERR DAM ROAD	1-1.4 MI W FAS 354	1	1	2	0	4	45	800	3.42	63	45	52.1	" "
14	AIRPORT ROAD	1.4 MI E 93 ST IGN	0	2	0	1	3	40	600	3.42	63	49	52.0	" "
15	LEMERY LANE	CO RD 2 MI E US 93	0	3	0	0	3	40	700	2.94	56	57	51.7	" "
16	ROCKY POINT ROAD	KINGS POINT RD INT	1	1	2	1	5	50	1000	3.42	63	35	49.9	" "
17	TIMBERLANE ROAD	CURVE 3 MI E US 93	0	1	0	2	3	40	700	2.94	56	49	49.4	" "
18	NORTH CROW ROAD	2.5-3 MI E OLD 93	2	0	0	2	4	45	800	3.42	63	37	49.3	" "
19	FINLEY POINT ROAD	JUNCT HWY 35 WEST	2	2	1	0	5	50	1200	2.85	55	42	49.3	" "
20	NORTH COUTURE LOOP	1.0 MI S US 93	2	0	0	1	3	40	600	3.42	63	40	48.8	" "
21	CANYON MILL ROAD	1.5-2 MI E OLD 93	0	0	1	2	3	40	900	2.28	46	57	47.9	" "
22	SOUTH FERNDALE ROAD	FAS 209 TO .5 MI S	0	1	3	0	4	45	1000	2.74	53	37	45.6	" "
23	NORTH CROW ROAD	JUNCT OLD US 93	3	2	0	1	6	54	2000	2.05	42	40	44.9	" "
24	PABLO MAIN STREET	BUSINESS DIST	0	2	1	2	5	50	2400	1.43	32	53	43.7	" "
25	MINK LANE	TO .5 MI S FAS 211	0	2	0	1	3	40	600	3.42	63	22	43.1	" "
26	HILLSIDE ROAD	2 MI E ST IGNATIUS	0	1	1	1	3	40	1100	1.87	39	49	42.9	" "
27	OLD US 93	.5 MI S NORTH CROW	1	2	0	0	3	40	1500	1.37	31	49	39.4	" "
28	KERR DAM ROAD	FAS 354 INTERSECT	0	0	3	0	3	40	900	2.28	46	22	36.6	" "
29	TIMBERLANE ROAD	1.5 MI E US 93	1	1	1	0	3	40	900	2.28	46	22	36.6	" "
30	OLD US 93	CURVE JUST S PABLO	1	0	0	2	3	40	1600	1.28	29	40	35.6	" "
31	OLD US 93	.3 MI US 93 N PABL	2	0	0	1	3	40	1600	1.28	29	22	29.9	" "
32	FINLEY POINT ROAD	CURVE I MI NW H 35	0	2	0	1	3	40	2400	0.86	21	22	26.6	" "
		TOTALS =	47	45	30	42	164							
		AVE. YEAR =	1.5	1.4	0.9	1.3	5.1	48.7	1184.4	3.2	57.7	41.1	49.7	

Phase 3 - Analysis of Data; included the determination of hazard indexes for each location by using the Federal Highway Administration Report No. FHWA-RD-77-83 "Identification of Hazardous Locations". Computations involved with accidents, volumes, capacities, indicator values and other aspects of hazard indexes were performed on the microcomputer. From these computations a preliminary hazard ranking list was prepared.

Phase 4 - Evaluation of Corrective Measures and Priority Listing; included the determination of improvements that would reduce or eliminate certain types of accidents in general at the study locations. Preliminary designs of those improvements included signing, geometric changes, and reconstruction. The improvements were recommended on a short term basis. In most cases, the nature of the sites was such that long term improvements could not be recommended.

Cost effectiveness calculations of the improvements at each location were determined by preparing preliminary cost estimates and computing economic benefits to arrive at a benefit/cost ratio. The method used to determine benefit/cost ratios is identical to that used by the Montana Department of Highways Project Planning Section. All values used in the formulation were supplied by Hank Butzlaff, supervisor of that section. The composite hazard index ranking and benefit/cost ratio, then determined the final priority listing.

ERROR ANALYSIS

The analysis of high hazard accident sites by the methods published in FHWA Report No. FHWA-RD-77-83 intrinsically contains some degree of error due to subjective data collection and computational bias. In the application of the method, certain other innate errors appear in various forms.
A cursory analysis of these error sources and the relative degree of effect each has on the final index ranking is represented in this section.

SITE SELECTION

Site selection involved the use of the three major indexes used in the computation of hazard indexes. Therefore, the possible error of not selecting the most hazardous sites in the county was greatly reduced.

NUMBER OF ACCIDENTS INDICATOR

The average number of accidents per site was 8.1 which would result in an average indicator value of 61. Assuming the worst conditions for error analysis purposes, two reports may be incorrect either by misplaced location or lost, which would produce negative bias. This would result in a negative bias of 10%.

ACCIDENT RATE INDICATOR

Since volume data for the exact period of accident reporting may not exist at some locations, factors adjusting past or present Average Daily Traffic (ADT) to the analysis period were used. Assuming the worst cases of no growth or double growth, the actual ADT during the reporting period would have created a negative or positive bias of 6% in the indicator value.

The volume capacity indicator would present a similar bias of lessor magnitude due to ADT factoring.

HAZARD INDEX ERROR

Based on the foregoing assumptions, the average error in the hazard index of 61.4 could be negative or positive. It is unlikely that all bias would be directed in a positive or negative direction. It is most probable that compensating errors occurred in the majority of instances.

HAZARD INDEX - ANALYSIS RESULTS

Seven hazard indexes were used as the preliminary basis of ranking hazardous sites. The following are brief descriptions of each index including data format, data collection, indicator scaling and site ranking with respect to each index.

1. **Number of Accidents** - This indicator provided a historical background of accidents at the investigation site. In the case of Lake County, a four year period was used, which included 1985 - 1988. The accident reports were photo copied in Helena and provided to the consultant. The data represents all reports filed on county roads in Lake County.

Figure 3. is a curve extracted from the FHWA report which is used to determine the indicator value. The data base is number of accidents per year. This indicator as all of the seven indicators used in the report is scaled between 0 and 100. An average of two accidents per year in a three year period indicates a hazardous location (indicator value of 33). Ten accidents on the average per year is used to designate a very hazardous location (indicator value of 67). In the case of this study where low volume roads are involved, the total number of accidents per site criteria was used to extract the index value. This higher value is therefore more consistent with the level of the the other index values. Using an annual rate would scale down the importance of this indicator relative to other index values.

Table 3 is the computer generated ranking of all sites based on this indicator.

TABLE 3. SITE RANKING BY NUMBER OF ACCIDENTS

RANK NO.	MAJOR ROUTE	ACCIDENTS / YEAR 85	86	87	88	TOTAL NO. ACC.	NO. ACC. INDEX
1	TERRACE LAKE ROAD	5	4	3	5	17	81
2	TURTLE LAKE ROAD	6	1	3	1	11	69
3	TIMBERLANE ROAD - 1.0 MILES	2	1	2	4	9	64
4	TIMBERLANE ROAD - 2.5 MILES	1	1	1	6	9	64
5	OLD U.S. 93 - CANYON MILL	1	3	3	1	8	61
6	ROCKY POINT ROAD	2	2	1	2	7	58
7	OLD U.S. 93 CURVE S. OF PABLO	3	0	1	3	7	58
8	ST. MARY'S ROAD	1	2	0	4	7	58
9	FINLEY POINT ROAD	2	1	1	0	4	45
10	ROUND BUTTE ROAD - SLOAN ROAD	0	1	0	1	2	33
	TOTALS =	23	16	15	27	81	
	AVERAGES =	2.3	1.6	1.5	2.7	8.1	59.2

2. Accident Rate Indicator - This indicator somewhat compensates for any incomplete information provided by the number of accident indicators, in that an exposure value is provided by the relationship between accidents and the total volumes of vehicles using the facility.

The data base for this indicator is expressed as the number of accidents per million entering vehicles. In the case of an intersection, "million entering vehicles" is the sum of the daily average approach volumes on all legs of the intersection, multiplied by the number of days in the analysis period.

The accident rate indicator is a very important part of the hazard index ranking method and data collection is possible only when a continued program of traffic counting has been performed. Spot counts adjusted by yearly volume increases, seasonal variations, daily variations and hourly variations were necessary

at most of the sites to develop an average daily traffic figure applied to the analysis period. The length of the cluster areas was extremely variable in this study. If the volumes were applied on a per site basis, the bias would be toward the longer sections. Therefore, the indicator was used by calculating number of accidents per million vehicles per 0.2 mile sections.

Figure 4 represents the graphic plot of accident rate versus indicator value. As before, the indicator value ranges between 0 and 100.

Table 4 is the computer generated ranking of sites based on this indicator.

TABLE 4. SITE RANKING BY ACCIDENT RATE

RANK NO.	INTERSECTION LOCATION	TOTAL ACCIDENTS 4 YEARS	1989 ADT	4 YEAR PERIOD AVERAGE	ACCIDENTS PER MVE	ACC RATE IND VAL
1	ST. MARY'S ROAD	7	150	150	10.65	100
2	ROUND BUTTE ROAD - SLOAN ROAD	2	220	220	6.23	94
3	TURTLE LAKE ROAD	11	800	768	3.27	61
4	TIMBERLANE ROAD - 1.0 MILES	9	350	336	3.06	58
5	TIMBERLANE ROAD - 2.5 MILES	9	300	288	2.85	55
6	OLD U.S. 93 CURVE S. OF PABLO	7	1,800	1,728	1.39	31
7	ROCKY POINT ROAD	7	1,350	1,296	1.23	28
8	OLD U.S. 93 - CANYON MILL	8	1,586	1,522	1.20	27
9	TERRACE LAKE ROAD	17	1,500	1,440	1.16	26
10	FINLEY POINT ROAD	4	1,600	1,536	0.89	21
	AVERAGE VALUES =	8	966	928	3	50

3. Accident Severity Indicator - Although there are many factors involved in the severity of accidents, statistical studies over a significant number of years have given fairly reliable dollar values in terms of economic loss for each type of accident. The accident severity indicator correlates a probable cause and effect relationship which aids in the determination of the level of accident reduction measures required. Severity values can also be used as a determinant of benefits resulting from various improvements.

The data base for accident severity is average relative severity in thousands of dollars. Data collection necessary for the use of the severity index is made possible by the accident report form. Dollar values for severity were provided by Hank Butzlaff of the Montana Department of Highways. They are: Fatal Accident = $500,000, Injury Accident = $11,000 and Property Damage Accident = $1,500.

The FHWA report presents the relative severity index values for each type of accident. Once the type of accident has been established, Figure 5 enables the user to assess the indicator value. Figure 5 is a graphic plot of the average severity in thousands of dollars versus the indicator value which is based on a scale of 0 to 100.

Table 5 is the computer generated ranking of sites based on this indicator.

TABLE 5. SITE RANKING BY ACCIDENT SEVERITY

RANK NO.	INTERSECTION LOCATION	SUM OF SEVERITY VALUES	TOTAL NO. ACC.	AVERAGE SEVERITY INDEX	INDICATOR VALUE
1	ROUND BUTTE ROAD - SLOAN ROAD	$511,000	2	$255,500	100
2	OLD U.S. 93 - CANYON MILL	$548,500	8	$68,563	100
3	ROCKY POINT ROAD	$48,500	7	$6,929	56
4	ST. MARY'S ROAD	$48,500	7	$6,929	56
5	TIMBERLANE ROAD - 1.0 MILES	$61,000	9	$6,778	55
6	TIMBERLANE ROAD - 2.5 MILES	$61,000	9	$6,778	55
7	FINLEY POINT ROAD	$25,000	4	$6,250	54
8	TERRACE LAKE ROAD	$73,000	17	$4,294	46
9	OLD U.S. 93 CURVE S. OF PABLO	$29,500	7	$4,214	46
10	TURTLE LAKE ROAD	$35,500	11	$3,227	41
	TOTAL SEVERITY $ =	$1,441,500			
	TOTAL NO. ACC. =		81		
	AVE. SEVERITY / ACC. =			$17,796	
	AVE. IND. VAL / SITE =				61

4. Volume to Capacity Ratio Indicator - This indicator not only produces exposure rates but also incorporates existing roadside features and conditions such as traffic type, turning directions, volume mix and number of lanes.

Computation of the volume capacity indicator is expressed as follows:

$$V/C = ADT/24 \text{ HOUR CAPACITY}$$

Again the low volume nature of these sites would dilute the relative importance of this indicator if calculated in this manner. Therefore, volume/capacity calculation using the 1985 Highway Capacity Manual procedures were used and expressed as a peak hour V/C. If the above formula were used, the maximum index value would have been less than 10 and more than half of the sites would have been at or near zero.

Data required for the volume capacity ratio involves field measurements of existing geometrics, turning counts and volume mix.

The capacity of each section of road or intersection is computed through methodology presented in the 1985 Highway Capacity Manual using FHWA computer software. Although this indicator is cumbersome to use by inexperienced personnel, its inclusion is considered necessary and correlates well in hazardous index ranking.

Figure 6. presents a graphic plot of the volume capacity ratio versus the indicator value which is also scaled between 0 and 100.

Table 6. is the computer generated ranking of the sites based on this indicator.

TABLE 6. SITE RANKING BY VOLUME/CAPACITY RATIOS

RANK NO.	INTERSECTION LOCATION	PEAK HOUR CAPACITY	PEAK HOUR FLOW	V/C RATIO	V/C INDICATOR VALUE
1	FINLEY POINT ROAD	417	160	0.38	64
2	TERRACE LAKE ROAD	449	150	0.33	58
3	TURTLE LAKE ROAD	244	80	0.33	57
4	OLD U.S. 93 CURVE S. OF PABLO	719	180	0.25	48
5	OLD U.S. 93 - CANYON MILL	719	156	0.22	43
6	ROCKY POINT ROAD	700	135	0.19	40
7	TIMBERLANE ROAD - 1.0 MILES	404	35	0.09	23
8	TIMBERLANE ROAD - 2.5 MILES	404	30	0.07	20
9	ROUND BUTTE ROAD - SLOAN ROAD	520	22	0.04	14
10	ST. MARY'S ROAD	372	15	0.04	13
	AVERAGE VALUES	495	96	0.19	38

5. **Sight Distance Indicator** - This indicator is of significant value in rural locations, especially at intersecting roads. Even though the weighting factor in the hazard index computation is low, it is still considered valuable in determining

deficiencies on unimproved county roads.

The data format for using the sight distance indicator is the ratio of actual sight distance to desirable sight distance. The FHWA report presents the minimum stopping sight distance on wet pavement for the various design speeds. Actual stopping sight distance is the distance from the drivers position to the point where a stop may be required to avoid a hazardous maneuver or direct collision.

The data format for this indicator is the sight distance ratio of actual over desirable. Collection of the sight distance data requires field measurements of sight distance and determination of average travel speeds. Figure 7. presents a graphic plot of the sight distance ratio versus the indicator value which ranges from 0 to 100.

Table 7. is the computer generated ranking of sites based on this indicator.

TABLE 7. SITE RANKING BY SIGHT DISTANCE

RANK NUMBER	INTERSECTION LOCATION	N SD	REQ SD	RATIO	IND VAL	S SD	REQ SD	RATIO	IND VAL	E SD	REQ SD	RATIO	IND VAL	W SD	REQ SD	RATIO	IND VAL	*WT. IND VAL
1	TERRACE LAKE ROAD	300	600	0.50	100	300	600	0.50	100	500	350	1.43	14	500	350	1.43	14	100
2	ST. MARY'S ROAD	200	275	0.73	65	200	275	0.73	65	250	500	0.50	100					88
3	TIMBERLANE ROAD - 1.0 MILES	200	275	0.73	65					150	275	0.55	99					88
4	TIMBERLANE ROAD - 2.5 MILES					150	275	0.55	99	200	275	0.73	65	200	275	0.73		88
5	TURTLE LAKE ROAD	300	275	1.09	30	300	275	1.09	30	300	500	0.60	88					69
6	OLD U.S. 93 - CANYON MILL	700	400	1.75	4	700	400	1.75	4	700	650	1.08	31	400	650	0.62	84	66
7	ROCKY POINT ROAD	600	400	1.50	11	600	400	1.50	11	400	650	0.62	84	800	650	1.23	22	63
8	FINLEY POINT ROAD	300	500	0.60	88	300	500	0.60	88	400	275	1.45	13	400	275	1.45	13	63
9	ROUND BUTTE ROAD - SLOAN ROAD	700	800	0.88	47					700	800	0.88	47	700	800	0.88	47	47
10	OLD U.S. 93 CURVE S. OF PABLO	700	525	1.33	17	700	525	1.33	17				2	900	800	1.13	0	12

AVERAGE INDICATOR VALUE = 68.4

6. Driver Expectancy Indicator - This indicator relates human behavior factors to existing road conditions. The value of this indicator is realized in the fact that the roadway geometrics and roadside culture are evaluated on a human judgement basis.

The data format for the driver expectancy index is the problem rating scale. Being a subjective indicator, the degree of expectancy is rated on a scale from 1 to 6, and the expectancy rating varies linearly with the indicator value as shown in Figure 8. The expectancy rating form can be found in the FHWA report for further reference.

Table 8. is the computer generated ranking of sites based on this indicator.

TABLE 8. SITE RANKING BY DRIVER EXPECTANCY

RANK NO.	INTERSECTION LOCATION	NB RATE	SB RATE	EB RATE	WB RATE	WGTD. RATE	IND VAL
1	ROUND BUTTE ROAD - SLOAN ROAD	5		5	6	5.3	89
2	TIMBERLANE ROAD - 2.5 MILES	5	5	6	5	5.3	88
3	OLD U.S. 93 - CANYON MILL	4	6	6	4	5.0	83
4	TERRACE LAKE ROAD			5	5	5.0	83
5	TIMBERLANE ROAD - 1.0 MILES	5	5	5	5	5.0	83
6	FINLEY POINT ROAD			5	5	5.0	83
7	OLD U.S. 93 CURVE S. OF PABLO	5	5		4	4.7	78
8	ST. MARY'S ROAD			5	4	4.5	75
9	TURTLE LAKE ROAD	3	5	4		4.0	67
10	ROCKY POINT ROAD	3	3			3.0	50

AVERAGE INDICATOR VALUE 77.9

7. **Information System Deficiencies Indicator** - This indicator also provides a value or subjective judgement on the sufficiency of traffic control devices which transfer necessary information to the operator.

The data format for the information system deficiencies indicator is similar to that of the driver expectancy indicator in that a value form is used to provide a rating between 1 and 6. The rating for this indicator is also plotted linearly between the indicator range values of 0 and 100 and is shown on Figure 9. The value rating form is for the information system deficiencies indicator. It is also presented in the FHWA report for further reference.

Table 9. is the computer generated ranking of sites based on this indicator.

TABLE 9. SITE RANKING BY INFORMATION DEFICIENCY

RANK NO.	INTERSECTION LOCATION	NB RATE	SB RATE	EB RATE	WB RATE	WGTD. RATE	IND VAL
1	ST. MARY'S ROAD			6	6	6.0	100
2	ROUND BUTTE ROAD - SLOAN ROAD	5		6	6	5.7	94
3	TURTLE LAKE ROAD	5	6	4		5.0	83
4	TIMBERLANE ROAD - 1.0 MILES	5	5	5	5	5.0	83
5	TIMBERLANE ROAD - 2.5 MILES	5	5	5	5	5.0	83
6	FINLEY POINT ROAD			5	5	5.0	83
7	TERRACE LAKE ROAD			5	5	5.0	83
8	OLD U.S. 93 - CANYON MILL	4	5	5	5	4.8	79
9	OLD U.S. 93 CURVE S. OF PABLO	5	4		4	4.3	72
10	ROCKY POINT ROAD	3	3			3.0	50

AVERAGE INDICATOR VALUE 81.3

HAZARD RANKING

Once all of the data had been collected and the indicator values computed, indicator values and necessary data were transferred to the hazard index computation matrix. Each indicator is weighted in accordance with the FHWA report. The weighting factors are fractional portions of unity. When all nine indicators established in FHWA report are used, the sum of weights is equal to one. In the case of Lake County, two indicators were omitted, the Traffic Conflict Indicator and the Erratic Maneuvers Indicator. Their exclusion from the study was not felt to be any deterrent in the ranking of hazardous sites. The use of seven indicators provides an 88.6% confidence in strength of evaluation.

Based on the hazard analysis for each site, a matrix of indicator values and final hazard index ratings was constructed on the Lotus system and a hazard index ranking was completed. Table 10. lists this ranking by site number, location, indicator values and hazard index. Also shown is statistical information for the indicator values and hazard index.

During the process of field data collection and subsequent indicator computations, it was discovered that values for the two subjective indicators could vary widely between consecutive observations and among non-experienced observers. Lake County will most likely retain traffic personnel who will update the high hazard priority list and therefore these indicators should remain as part of the hazard index ranking.

TABLE 10. SITE RANKING BY HAZARD INDEX VALUES - SUMMARY OF INDICATOR VALUES

RANK NO.	INTERSECTION LOCATION	# OF ACC. IND VAL	# OF ACC. PART H.I.	ACC. RATE IND VAL	ACC. RATE PART H.I.	SEVERITY IND VAL	SEVERITY PART H.I.	V/C RATIO IND VAL	V/C RATIO PART H.I.	SIGHT DIST IND VAL	SIGHT DIST PART H.I.	EXPECT. IND VAL	EXPECT. PART H.I.	INFO DEF. IND VAL	INFO DEF. PART H.I.	TOTAL HAZARD INDEX
	* RELATIVES WEIGHTS :		0.163		0.224		0.190		0.082		0.074		0.148		0.115	1.000
1	ROUND BUTTE ROAD - SLOAN ROAD	33	5.38	94	21.06	100	19.00	14	1.15	47	3.48	89	13.17	94	10.81	74.04
2	ST. MARY'S ROAD	58	9.45	100	22.40	56	10.64	13	1.07	88	6.51	75	11.10	100	11.50	72.67
3	OLD U.S. 93 - CANYON HILL	61	9.94	27	6.05	100	19.00	43	3.53	66	4.88	83	12.28	79	9.09	64.77
4	TIMBERLANE ROAD - 1.0 MILES	64	10.43	58	12.99	55	10.45	23	1.89	88	6.51	83	12.28	83	9.55	64.10
5	TIMBERLANE ROAD - 2.5 MILES	64	10.43	55	12.32	55	10.45	20	1.64	88	6.51	88	13.02	83	9.55	63.92
6	TURTLE LAKE ROAD	69	11.25	61	13.66	41	7.79	57	4.67	69	5.11	67	9.92	83	9.55	61.94
7	TERRACE LAKE ROAD	81	13.20	26	5.82	46	8.74	58	4.76	100	7.40	83	12.28	83	9.55	61.75
8	FINLEY POINT ROAD	45	7.34	21	4.70	54	10.26	64	5.25	63	4.66	83	12.28	83	9.55	54.04
9	OLD U.S. 93 CURVE S. OF PABLO	58	9.45	31	6.94	46	8.74	48	3.94	12	0.89	78	11.54	72	8.28	49.79
10	ROCKY POINT ROAD	58	9.45	28	6.27	56	10.64	40	3.28	63	4.66	50	7.40	50	5.75	47.46
	AVERAGE VALUES :	59.1		50.1		60.9		38.0		68.4		77.9		81.0		61.4
	STANDARD DEVIATIONS :	12.3		27.3		20.2		18.2		24.2		11.1		12.6		8.3

EXPLANATION OF IMPROVEMENTS

The recommended improvements presented within this report are of two types. Short term improvements indicate the minimum amount of upgrading or modifications necessary to increase driver expectancy and to update the site to current standards. Long term improvements are normally considered viable when severe conditions at the site prevent short term improvements from completely satisfying the control measures necessary to prevent future problems. Since all of the long term improvements are dependant upon significant changes in the future operations and most of the sites were not of a nature that reliable predictions could be made, no costs or project ranking was completed. Many of the recommended improvements have sufficient latitude so that alternative measures could be suggested during design. The selection of recommended improvements was based on subjective engineering judgement.

At some of the sites, it was noted that a few traffic control devices were not in compliance with MUTCD. There also may be several locations where deficiencies may be critical and should be corrected as soon as possible.

In most cases, pavement markings were recommended. Ideally, all county roads should be striped, where warranted. However, past budgets have not allowed for this work to be completed. The county should consider contracting with the Department of Highways, as other Montana counties have done, to stripe the most critical county roads. When done in large quantities, pavement markings can be obtained at a relatively economical price.

The improvement sketches in all cases should not be considered design plans. The drawings are preliminary and are intended to present improvement concepts only in enough detail to provide the measure of control necessary and to provide cost estimates. In some cases, detailed survey data; design research; design plans and specifications; and construction layout will be necessary to effectively achieve the improvements.

BENEFIT/COST RATIOS

Costs - are developed by preliminary applying unit costs to required quantities based either on current prices as tabulated from average bid prices of similar projects or, where applicable, on prices established by Montana Department of Highways Project Planning Section. The costs should in no way be considered a quote or final estimate of actual work.

The following are traffic control devices and allowable costs that are eligible for funding by the Montana Department of Highways through their Off-System Safety Program:

A. Signs:

1. 1 square foot to 6 square feet - $ 100.00
2. 6.1 square feet to 10 square feet - $ 140.00
3. 10.1 square feet to 20 square feet - $ 170.00
4. supplementary sign on same post - $ 50.00

B. Delineators:

1. Design ""A" metal posts - $ 9.25
2. Design "A" flexible posts-6' - $ 20.00
3. Design "A" flexible posts-27" - $ 6.00

C. Guardrail:

1. New "W" Beam rail (per foot) - $ 8.00
2. "W" Beam end treatment (each) - $1,000.00
3. New concrete rail (per foot) - $ 16.00
4. New concrete end tapers (per foot) - $ 16.00

Even though Lake County maintenance crews are capable of performing a good deal of work, costs related to physical changes in the roadway section are based on contract prices in order to correlate with costs requiring contract bid letting. The costs do not include administrative, engineering or field layout for the recommended improvements at the one site which would require final design plans. Engineering design will generally be required to produce contract plans and specifications. These costs should be evaluated prior to planning improvement projects requiring bids.

Benefits - are estimated by applying accident reduction forecasts based on the type of improvement recommended. The forecasts are based on the subjective evaluation by an experienced traffic engineer. This evaluation is aided by knowledge of accident experience at similar locations with the improvements existing. Also statistical studies relating certain improvements to accident reduction are used as a guide ie, Roy Jorgenson and Associates, "Evaluation of Criteria for Safety Improvements on the Highway" (Washington, D.C.: U.S. Bureau of Public Roads, Office of Highway Safety, 1966. p. 316).

The forecasted reduction is expressed as a percentage of each type of accident. This percentage is multiplied by the percentage of all accidents represented by each type. The total percent reduction of all accidents at each site is the sum of all accidents reduction percentages for each type.

The method used to compute benefits in this study follows the Montana Department of Highways procedures. Those procedures were

programmed for the Lotus 123 Computer Software which provides a tabular summary of all variables in the computation.

If applied consistently, the economic benefit computation will provide a realistic estimate of average economic savings to society. The benefit amount should not be interpreted as a dollar value that Lake County will receive as a result of dollar outlay. It is a figure used to quantify the economic benefit to society that would occur if a certain number of accidents did not occur.

Ratio - of benefits to cost provides a numerical reference to the relative value of the recommended improvements. It is the desire of any improvement project to have a benefit-cost (B/C) ratio in excess of 1.0. If the B/C is less than 1.0 the project would have questionable justification. In this study, none of the sites had a B/C less than one. Table 11 is a computer generated summary of the B/C ranking for the study sites.

TABLE 11. SITE RANKING BY BENEFIT/COST RATIOS CALCULATION SUMMARY

RANK #	SITE LOCATION	PROJ LIFE	C O S T S CAPITOL COST IMPROVE	EQUIV ANNUAL COST	ANNUAL MAINT. COST CH.	TOTAL ANNUAL COST	B E N E F I T S Q	Afi	Apd	PFI	Ppd	ANNUAL BENEFIT	B/C RATIO	IND VAL
1	ST. MARY'S ROAD	5	$1,820	$480	$100	$580	$35,486	1.00	0.75	25%	25%	$9,427	16.25	93
2	OLD U.S. 93 - CANYON MILL	5	$5,030	$1,327	$150	$1,477	$35,486	1.25	0.75	38%	40%	$17,825	12.07	83
3	TIMBERLANE ROAD - 1.0 MILES	5	$4,790	$1,264	$100	$1,364	$35,486	1.00	1.25	40%	28%	$15,161	11.12	80
4	TIMBERLANE ROAD - 2.5 MILES	5	$6,505	$1,716	$100	$1,816	$35,486	1.00	1.25	37%	38%	$14,258	7.85	69
5	TERRACE LAKE ROAD	5	$4,820	$1,272	$100	$1,372	$35,486	1.25	3.00	20%	23%	$10,204	7.44	67
6	OLD U.S. 93 CURVE S. OF PABLO	5	$4,330	$1,142	$50	$1,192	$35,486	0.50	1.25	40%	40%	$8,083	6.78	64
7	ROCKY POINT ROAD	5	$7.165	$1,890	$100	$1,990	$35,486	1.00	0.75	32%	30%	$12,044	6.05	60
8	TURTLE LAKE ROAD	5	$3,390	$894	$400	$1,294	$35,486	0.50	2.25	30%	33%	$6,630	5.12	54
9	ROUND BUTTE ROAD - SLOAN ROAD	5	$8,830	$2,329	$50	$2,379	$35,486	0.50	0.00	45%	0%	$8,224	3.46	41
10	FINLEY POINT ROAD	5	$11,980	$3,160	$100	$3,260	$35,486	0.50	0.50	30%	30%	$5,714	1.75	19
	TOTALS :		$58,660	$15,474	$1,250	$16,724						$107,570		
	AVERAGES :	5	$5,866	$1,547	$125	$1,672						$10,757	7.79	63

COMPOUNDED INTEREST RATE : 10%
COST OF FATAL ACCIDENT : $500,000 (1986 NATIONAL SAFETY COUNCIL
COST OF INJURY ACCIDENT : $11,000
COST OF PROPERTY DAMAGE ACCIDENT ; $15,000
I/F RATIO SECONDARY : 17.7
ADTa/ADTb : 1.03

PRIORITY INDEX

The ranking of site improvement priorities cannot be directly dependent on the hazard ranking of the study sites. The value of the improvements must enter into the priority listing in the form of the benefit/cost ratio (B/C). The method of developing a composite Hazard Index - B/C listing must be dependent on the relative index scale used in the hazard index computation. Therefore, a correlation of scale between the B/C ratio and hazard indicator value was developed on the following assumptions:

1. The contributing conditions creating hazards at each site and the resulting hazard ranking is relatively independent of the cost of correcting these conditions.

2. Benefits to be derived from correcting hazardous situations at each site is indirectly proportional to the degree of hazardness.

3. The benefit-cost ratio, by virtue of benefit computation, is indirectly proportional to the number of accidents indicator and severity indicator, both of which are curvilinear functions.

4. The benefit-cost ratios can be rated on a scale of 0 to 100 based on a curvilinear function.

5. The B/C ratio of 1.0 is equivalent to an indicator value of 0 and the upper limit (indicator value = 100) must be chosen to encompass the majority of sites. In this case a B/C of 20.0 assumes the indicator value of 100.

Based on these assumptions a graphic plot of the B/C ratio versus B/C indicator value has been established and it is shown in

Figure 10. Since it has been graphed on semi-log paper the line appears linear.

Since the relative weighting of benefit-costs and hazardness is a controversial subject which would require research beyond the scope of this report, it is felt that the priority index should be based on 33% weighting for the benefit-cost ratio and 67% weight on the hazard index. Therefore, to establish a priority index the following formula has been devised:

$$\text{Priority Index} = (\text{Hazard Index}) \times (0.67) + (\text{Cost-Benefit Indicator}) \times (0.33)$$

Table 12. is the computer generated summary of priority ranking based on the composite hazard index - benefit/cost index values.

TABLE 12. SITE RANKING BY PRIORITY INDEX - CALCULATION SUMMARY

PRIORITY NUMBER	INTERSECTION LOCATION	HAZARD INDEX	WEIGHTED VALUE	BEN/COST INDEX	WEIGHTED VALUE	PRIORITY INDEX
1	ST. MARY'S ROAD	72.67	48.69	93	30.69	79.38
2	OLD U.S. 93 - CANYON MILL	64.77	43.40	83	27.39	70.79
3	TIMBERLANE ROAD - 1.0 MILES	64.10	42.95	80	26.40	69.35
4	TIMBERLANE ROAD - 2.5 MILES	63.92	42.83	69	22.77	65.60
5	TERRACE LAKE ROAD	61.75	41.37	67	22.11	63.48
6	ROUND BUTTE ROAD - SLOAN ROAD	74.04	49.61	41	13.53	63.14
7	TURTLE LAKE ROAD	61.94	41.50	54	17.82	59.32
8	OLD U.S. 93 CURVE S. OF PABLO	49.79	33.36	64	21.12	54.48
9	ROCKY POINT ROAD	47.76	32.00	60	19.80	51.80
10	FINLEY POINT ROAD	54.04	36.21	19	6.27	42.48
	AVERAGE VALUES :	61.48	41.19	63.00	20.79	61.98
	STANDARD DEVIATIONS :	8.29	5.55	20.38	6.72	9.99

PRIORITY INDEX = (HAZARD IND. x .67) + (BEN/COST IND. x .33)
* SIGNIFIES THOSE SITES CARRIED OVER FROM THE 1985 STUDY

IMPLEMENTATION

Within Table 13, the priority lists have been arranged in a manner in which budget considerations can readily be applied in the decision to proceed with improvements. The priority ranking was the major consideration in selecting which sites will be receiving funds first. Since limited funds are available, it is usually necessary to skip over a few higher priority projects to improve a greater number of sites as soon as possible. In this case, the improvement projects follow the priority ranking exactly. The listing assumes that eligible project costs will be funded by MDOH Off-system Safety funds. The MDOH project funding limit is less than $ 10,000 per project period, or else formal bid letting procedures would be required by MDOH. This dollar figure is used as the criteria to define construction groupings. The estimated costs not covered by MDOH funds are considered County funding requirements. If Lake County forces perform this work, the actual costs would probably be much less.

There is no timetable given for these improvements. It may be conceivable that MDOH could fund more than one of the site groups in a single year, depending on available funding. The County will want to request funding from MDOH by submitting this report to Steve Kologi, P.E., Administrator, Program Development Coordinator.

TABLE 13. PROJECT IMPLEMENTATION GROUPINGS

PRIOR. NUMBER	LOCATION	COST ESTIMATE	M.D.O.H. ELIGIBLE FUNDS	COUNTY FUNDS
1	ST. MARY'S ROAD	$1,820.00	$1,500.00	$320.00
2	OLD U.S. 93 CANYON MILL	$5,030.00	$2,820.00	$2,210.00
3	TIMBERLANE ROAD @ 1.0 MILES	$4,790.00	$1,620.00	$3,170.00
4	TIMBERLANE ROAD @ 2.5 MILES	$6,505.00	$2,580.00	$3,925.00
5	TERRACE LAKE ROAD	$4,820.00	$1,260.00	$3,560.00
	CONSTRUCTION GROUP #1 TOTALS =	$22,965.00	$9,780.00	$13,185.00
6	ROUND BUTTE ROAD	$8,830.00	$810.00	$8,020.00
7	TURTLE LAKE ROAD	$3,390.00	$1,050.00	$2,340.00
8	OLD U.S. 93 - PABLO CURVE	$4,330.00	$1,280.00	$3,050.00
9	ROCKY POINT ROAD	$7,165.00	$1,520.00	$5,645.00
10	FINLEY POINT ROAD	$11,980.00	$1,700.00	$10,280.00
	CONSTRUCTION GROUP #2 TOTALS =	$35,695.00	$6,360.00	$29,335.00
	TOTAL ALL CONSTRUCTION =	$58,660.00	$16,140.00	$42,520.00

PROGRAM CONTINUATION

Since the basic format of the study has been outlined and an initial priority list established, continuance of the program is strongly advised. The findings and recommendations of this study will soon become obsolete without continued updating at least on an annual basis.

The following recommendations in the continuance of the program are offered to Lake County:

1. The Department of Justice should continue to be assessed for copies of accident reports.

2. One person should be assessed with the responsibility of the program to insure that all data is being supplied, processed and filed.

3. An accident cluster map should be maintained.

4. Criteria should be developed for the inclusion of additional sites to be analyzed.

5. Coordinate any traffic counting programs that may exist or establish a counting program.

6. Analyze new sites according to the procedures of this study and include them in the priority list when warranted.

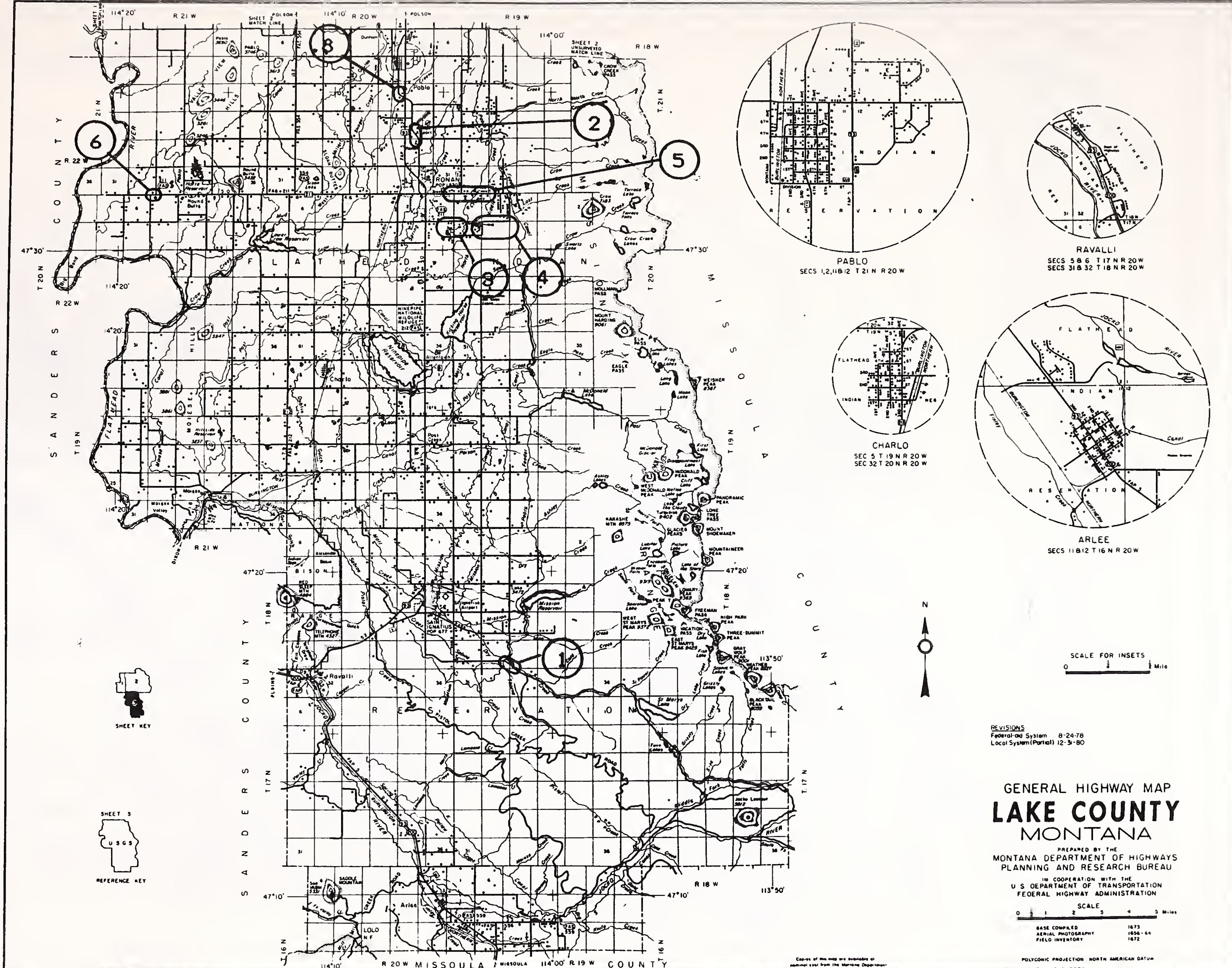
All of the data processing and storage can be handled by the Lotus 123 software. If an IBM compatible computer is available for use by the county, a copy of the data disk has been provided.

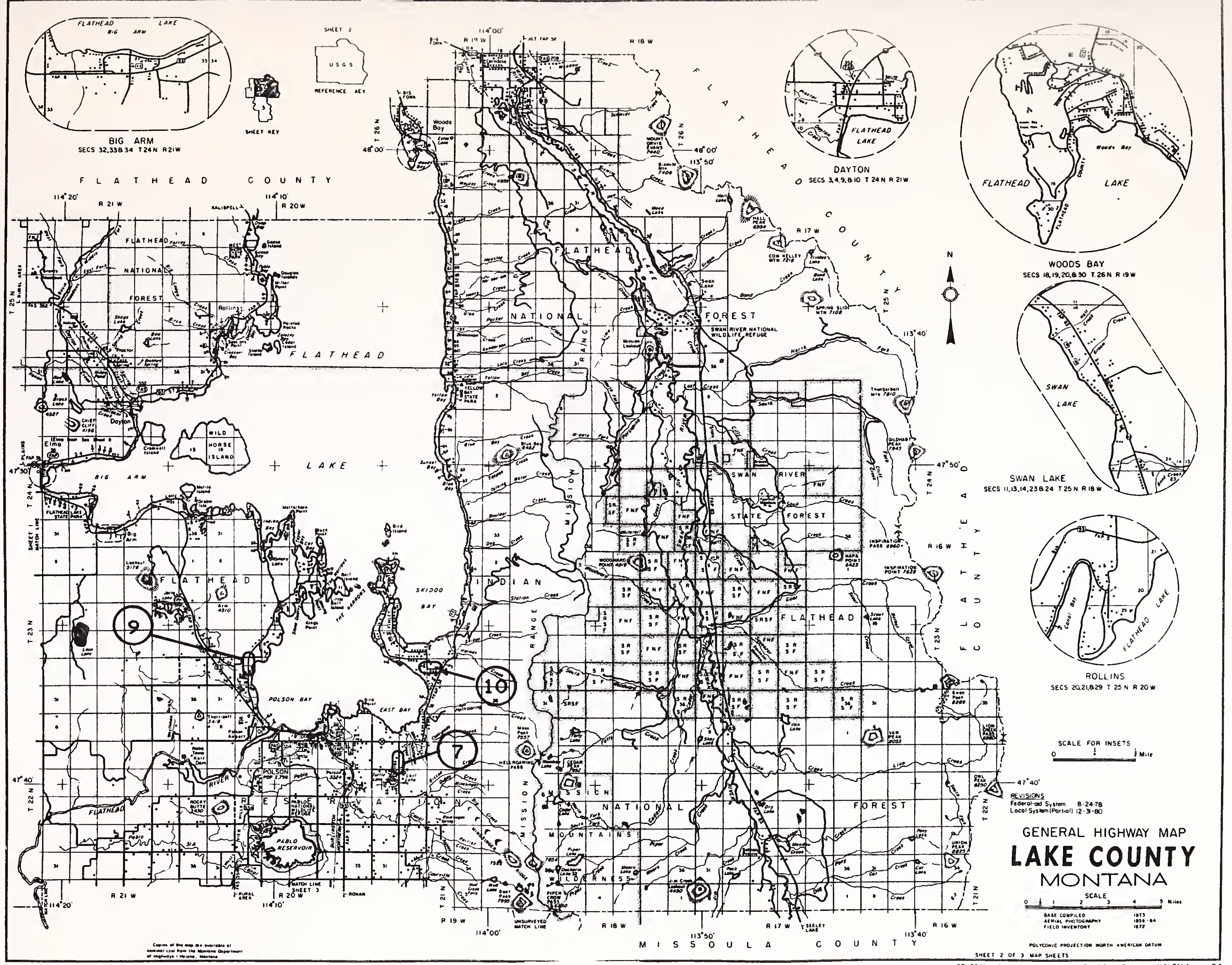
REPORT

FIGURES

FIGURE 1.

SITE LOCATION MAPS

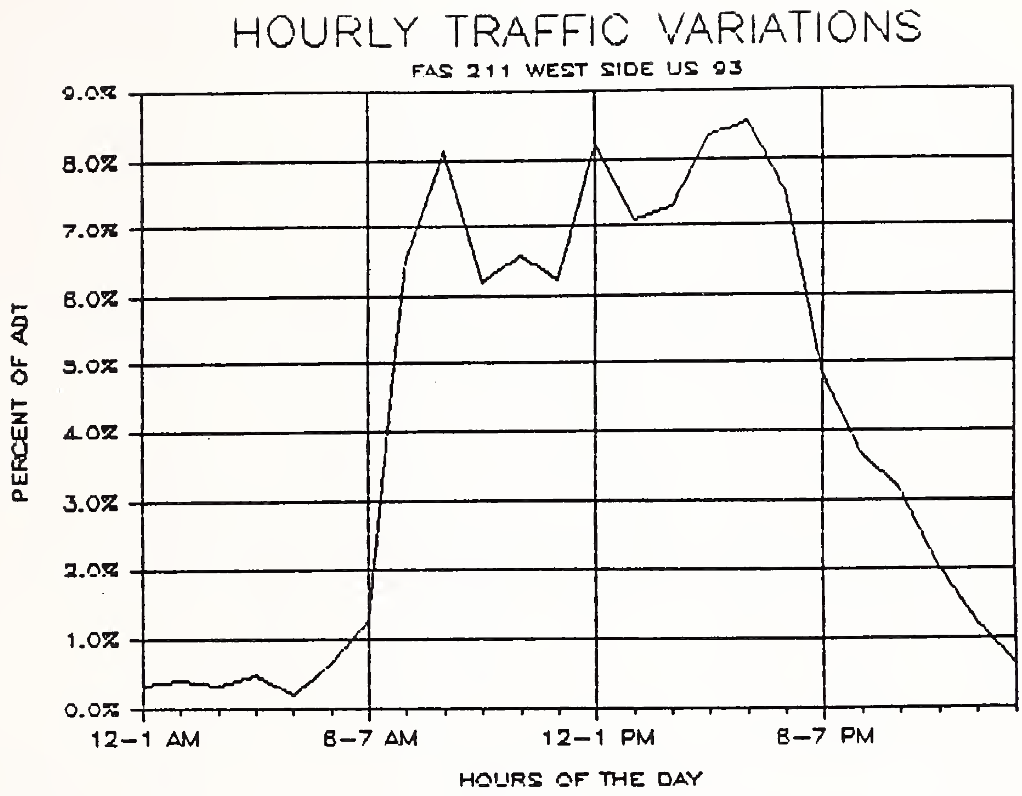

GENERAL HIGHWAY MAP
LAKE COUNTY
MONTANA
PREPARED BY THE
MONTANA DEPARTMENT OF HIGHWAYS
PLANNING AND RESEARCH BUREAU
IN COOPERATION WITH THE
U S DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
SCALE
0 1 2 3 4 5 Miles
BASE COMPILED 1673
AERIAL PHOTOGRAPHY 1656-64
FIELD INVENTORY 1672
POLYCONIC PROJECTION NORTH AMERICAN DATUM
SHEET 3 OF 5 MAP SHEETS
REVISIONS
Federal-aid System 8-24-78
Local System (Partial) 12-31-80
SCALE FOR INSETS
0 ½ 1 Mile
N
PABLO
SECS 1,2,11 & 12 T 21 N R 20 W
RAVALLI
SECS 5 & 6 T 17 N R 20 W
SECS 31 & 32 T 18 N R 20 W
CHARLO
SEC 5 T 19 N R 20 W
SEC 32 T 20 N R 20 W
ARLEE
SECS 11 & 12 T 16 N R 20 W
SANDERS COUNTY
MISSOULA COUNTY
FLATHEAD INDIAN RESERVATION
MISSION RANGE
NATIONAL BISON RANGE
Pablo
Ronan
Charlo
Saint Ignatius
Ravalli
Arlee
Moiese
Allentown
Ninepipe Reservoir
NINEPIPE NATIONAL WILDLIFE REFUGE
Mission Reservoir
Crow Reservoir
SLOAN BUTTES
MOIESE HILLS
VALLEY VIEW HILLS
FLATHEAD RIVER
JOCKO RIVER
McDONALD PEAK
MOUNT HARDING
MOUNT SHOEMAKER
MOUNTAINEER PEAK
PANORAMIC PEAK
GLACIER PEAKS
EAGLE PASS
MOLLMAN PASS
THREE-SUMMIT PEAK
SADDLE MOUNTAIN
LOLO N.F.
SHEET KEY
REFERENCE KEY
SHEET 5
U S G S
R 22 W
R 21 W
R 20 W
R 19 W
R 18 W
T 21 N
T 20 N
T 19 N
T 18 N
T 17 N
T 16 N
114°20'
114°10'
114°00'
113°50'
47°30'
47°20'
47°10'
Copies of this map are available at nominal cost from the Montana Department of Highways - Helena, Montana

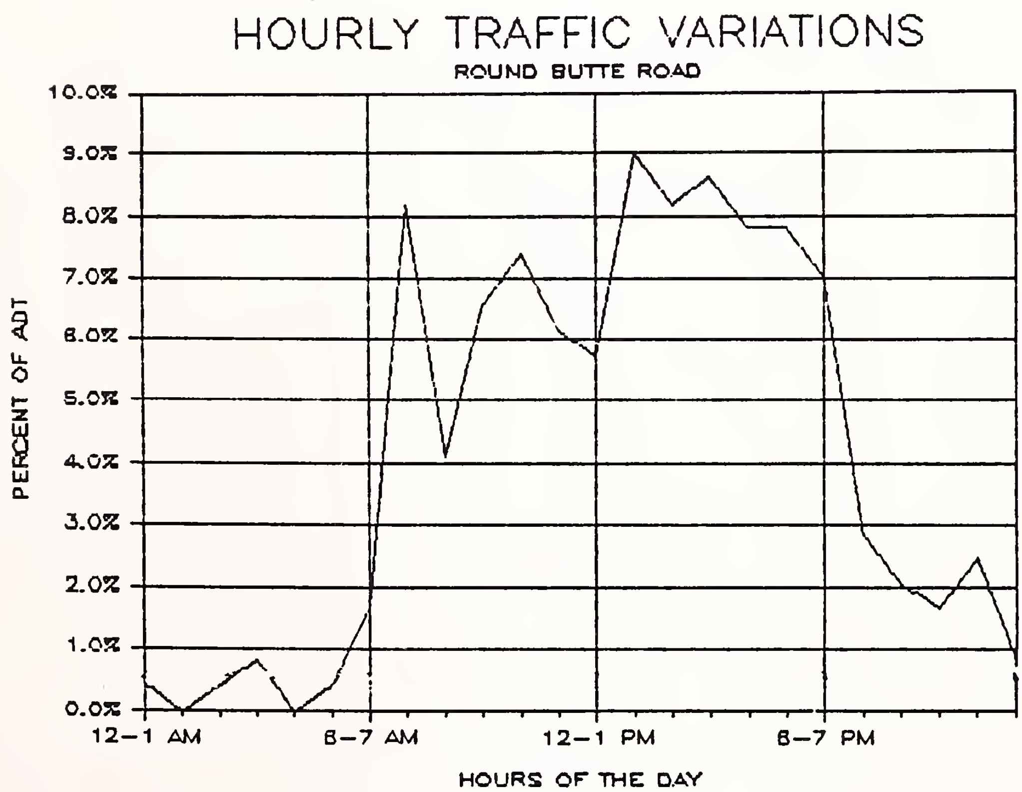


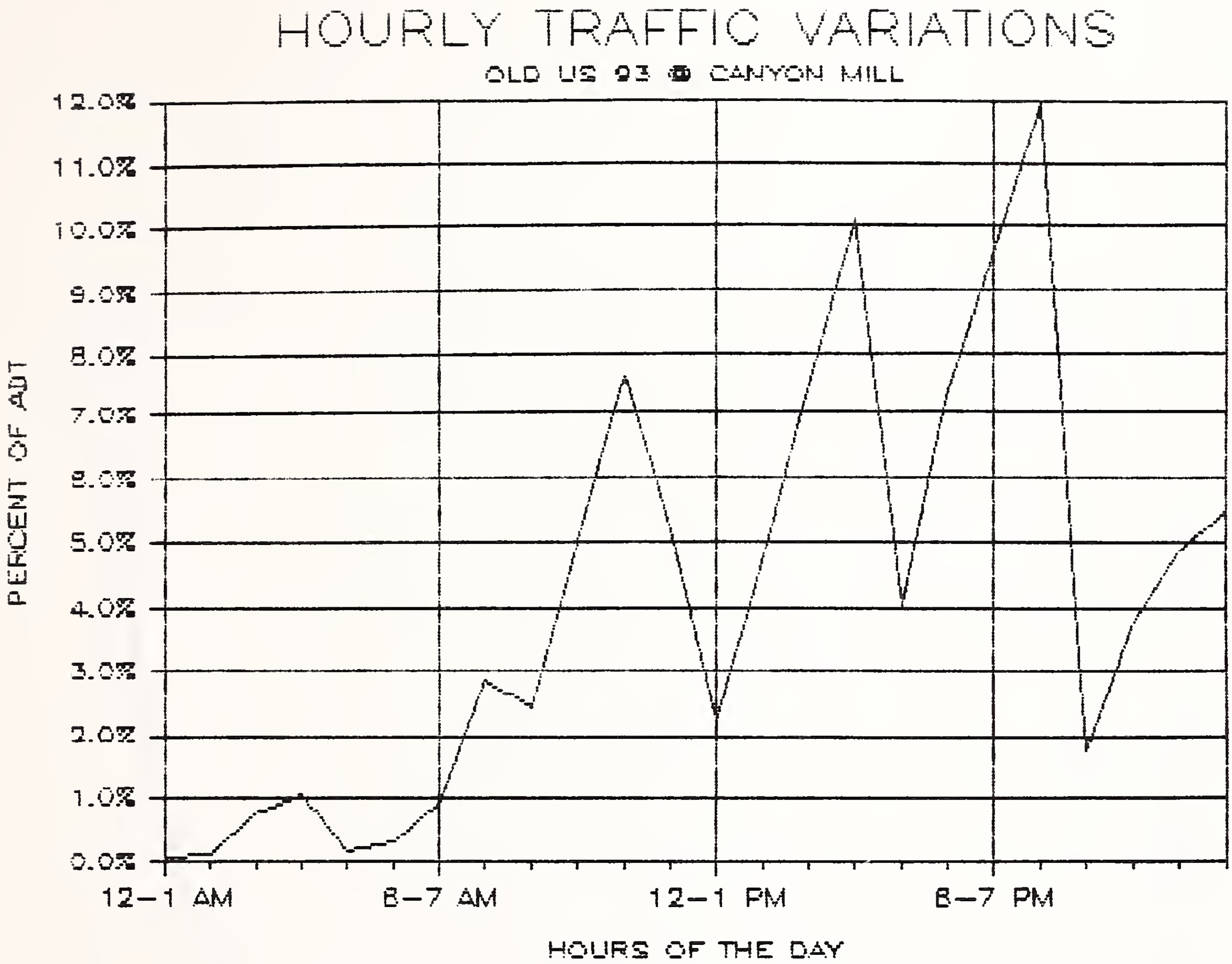
GENERAL HIGHWAY MAP
LAKE COUNTY
MONTANA
SCALE
0 1 2 3 4 5 Miles
BASE COMPILED 1973
AERIAL PHOTOGRAPHY 1958-64
FIELD INVENTORY 1972
POLYCONIC PROJECTION NORTH AMERICAN DATUM
SHEET 2 OF 3 MAP SHEETS
REVISIONS
Federal-aid System 8-24-78
Local System (Partial) 12-31-80
SCALE FOR INSETS
BIG ARM
SECS 32,33 & 34 T 24N R 21W
DAYTON
SECS 3,4,9,8,10 T 24N R 21W
WOODS BAY
SECS 18,19,20,& 30 T 26N R 19W
SWAN LAKE
SECS 11,13,14,23 & 24 T 25N R 18W
ROLLINS
SECS 20,21,& 29 T 25N R 20W
SHEET KEY
REFERENCE KEY
FLATHEAD COUNTY
MISSOULA COUNTY
FLATHEAD LAKE
FLATHEAD NATIONAL FOREST
FLATHEAD INDIAN RESERVATION
MISSION RANGE
MISSION MOUNTAINS
SWAN RIVER STATE FOREST
SWAN RIVER NATIONAL WILDLIFE REFUGE
WILD HORSE ISLAND
POLSON BAY
SKIDOO BAY
EAST BAY
PABLO RESERVOIR
POLSON POP 2,798
Copies of this map are available at nominal cost from the Montana Department of Highways - Helena, Montana

FIGURE 2.

HOURLY TRAFFIC VARIATIONS


HOURLY TRAFFIC VARIATIONS
FAS 211 WEST SIDE US 93
9.0%
8.0%
7.0%
6.0%
5.0%
4.0%
3.0%
2.0%
1.0%
0.0%
PERCENT OF ADT
12-1 AM
6-7 AM
12-1 PM
6-7 PM
HOURS OF THE DAY


HOURLY TRAFFIC VARIATIONS
ROUND BUTTE ROAD
10.0%
9.0%
8.0%
7.0%
6.0%
5.0%
4.0%
3.0%
2.0%
1.0%
0.0%
PERCENT OF ADT
12-1 AM
6-7 AM
12-1 PM
6-7 PM
HOURS OF THE DAY


HOURLY TRAFFIC VARIATIONS
OLD US 93 @ CANYON MILL
12.0%
11.0%
10.0%
9.0%
8.0%
7.0%
6.0%
5.0%
4.0%
3.0%
2.0%
1.0%
0.0%
PERCENT OF ADT
12-1 AM
6-7 AM
12-1 PM
6-7 PM
HOURS OF THE DAY

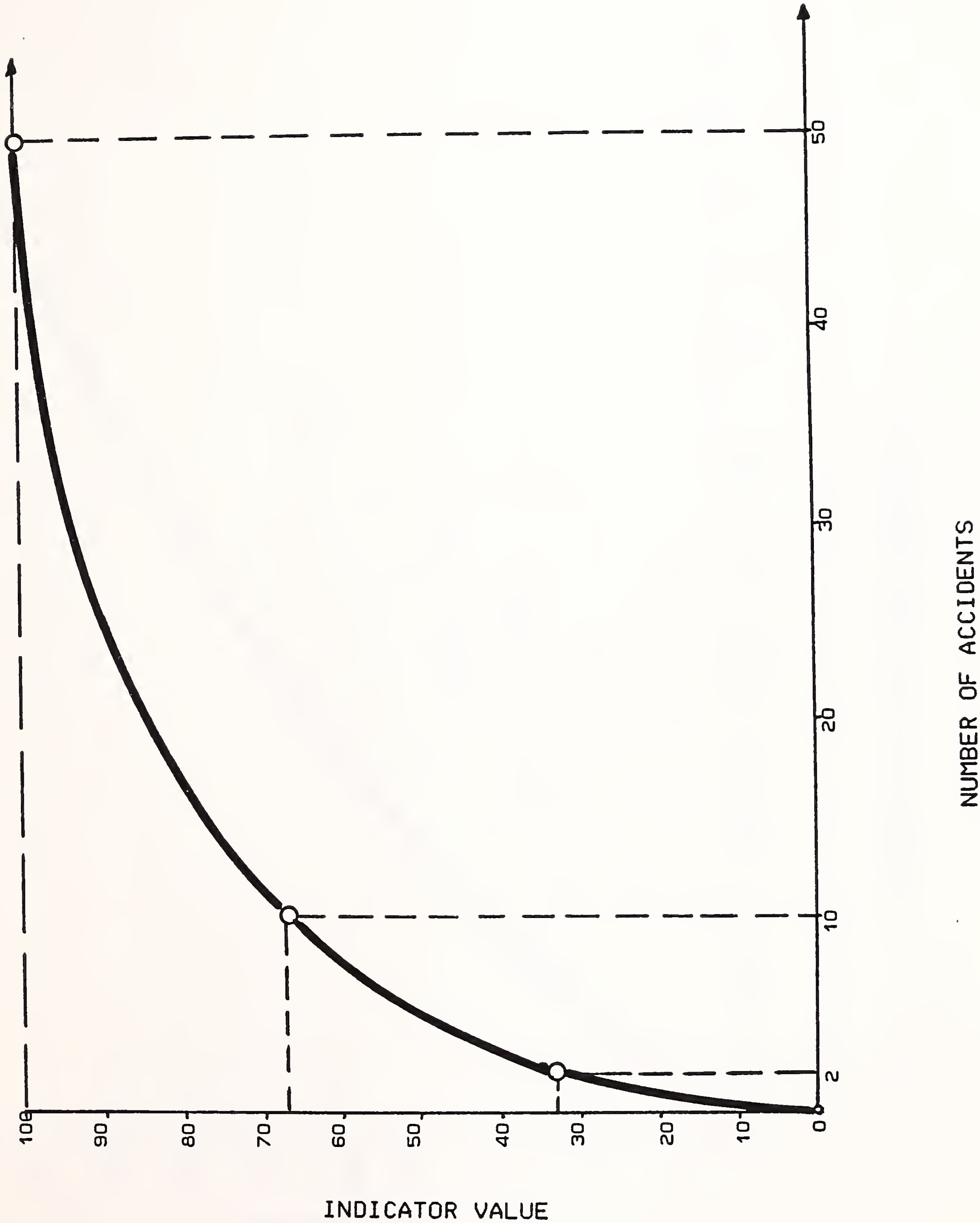


FIGURE 3. NUMBER OF ACCIDENTS INDICATOR

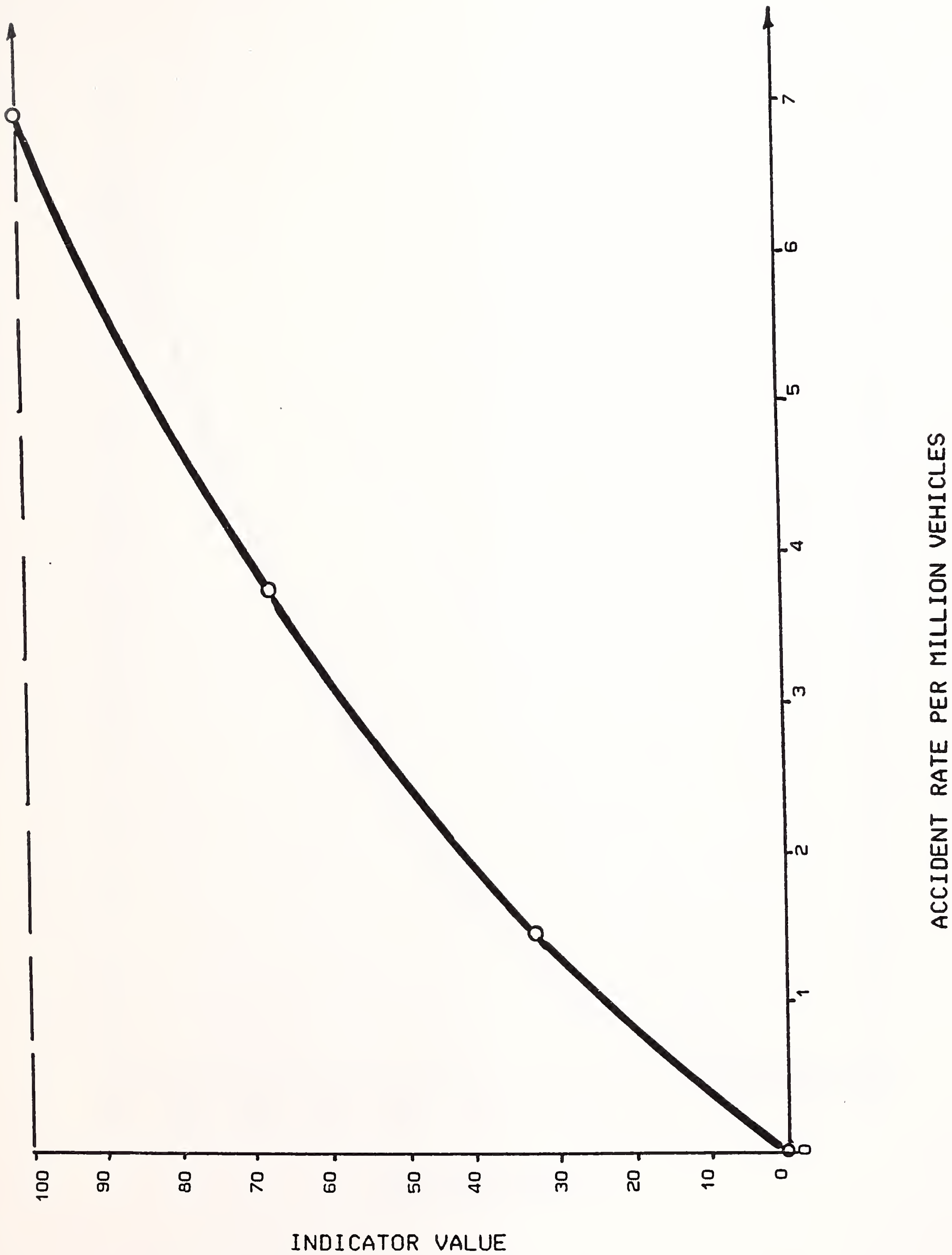


FIGURE 4. ACCIDENT RATE INDICATOR

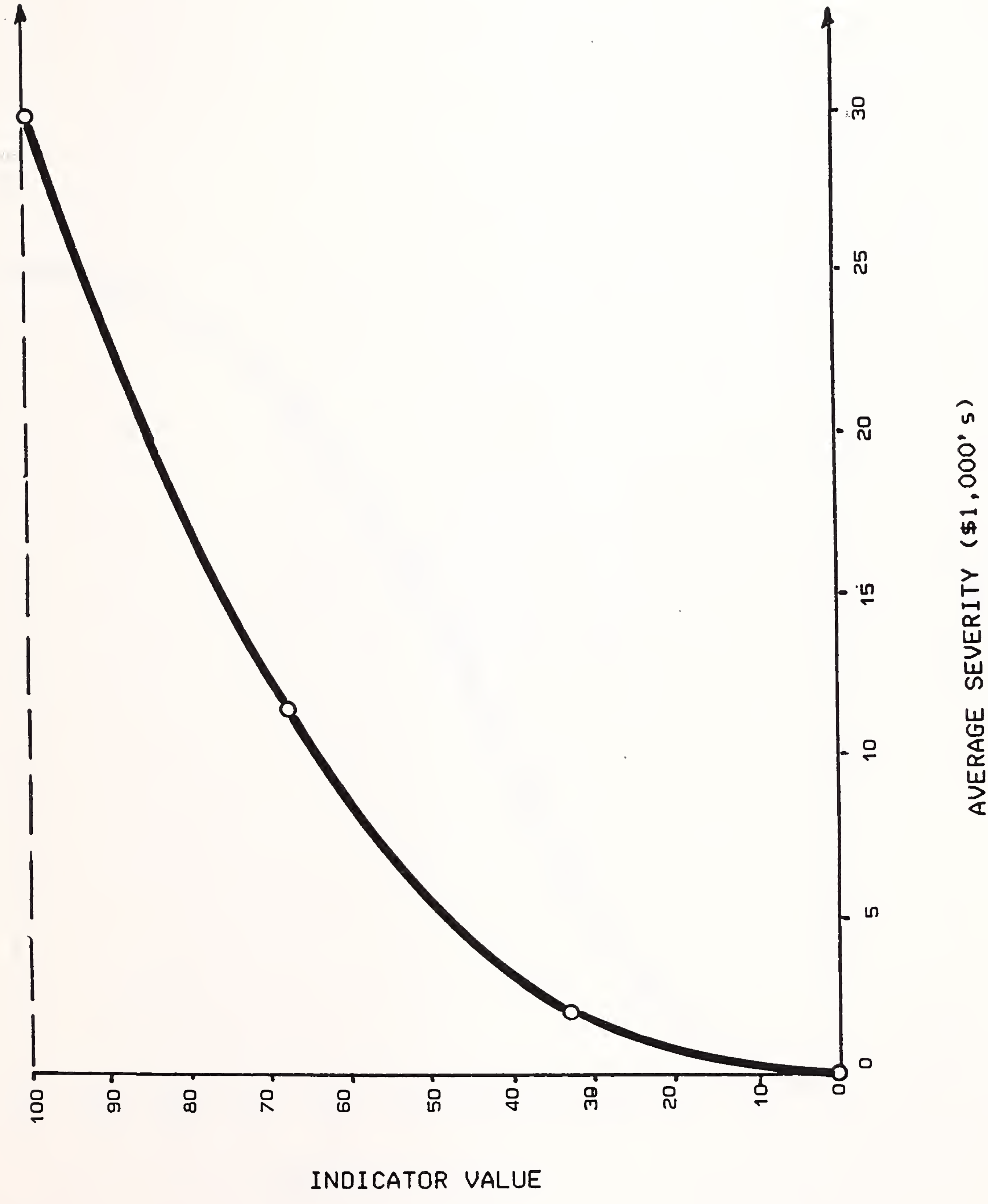


FIGURE 5. ACCIDENT SEVERITY INDICATOR

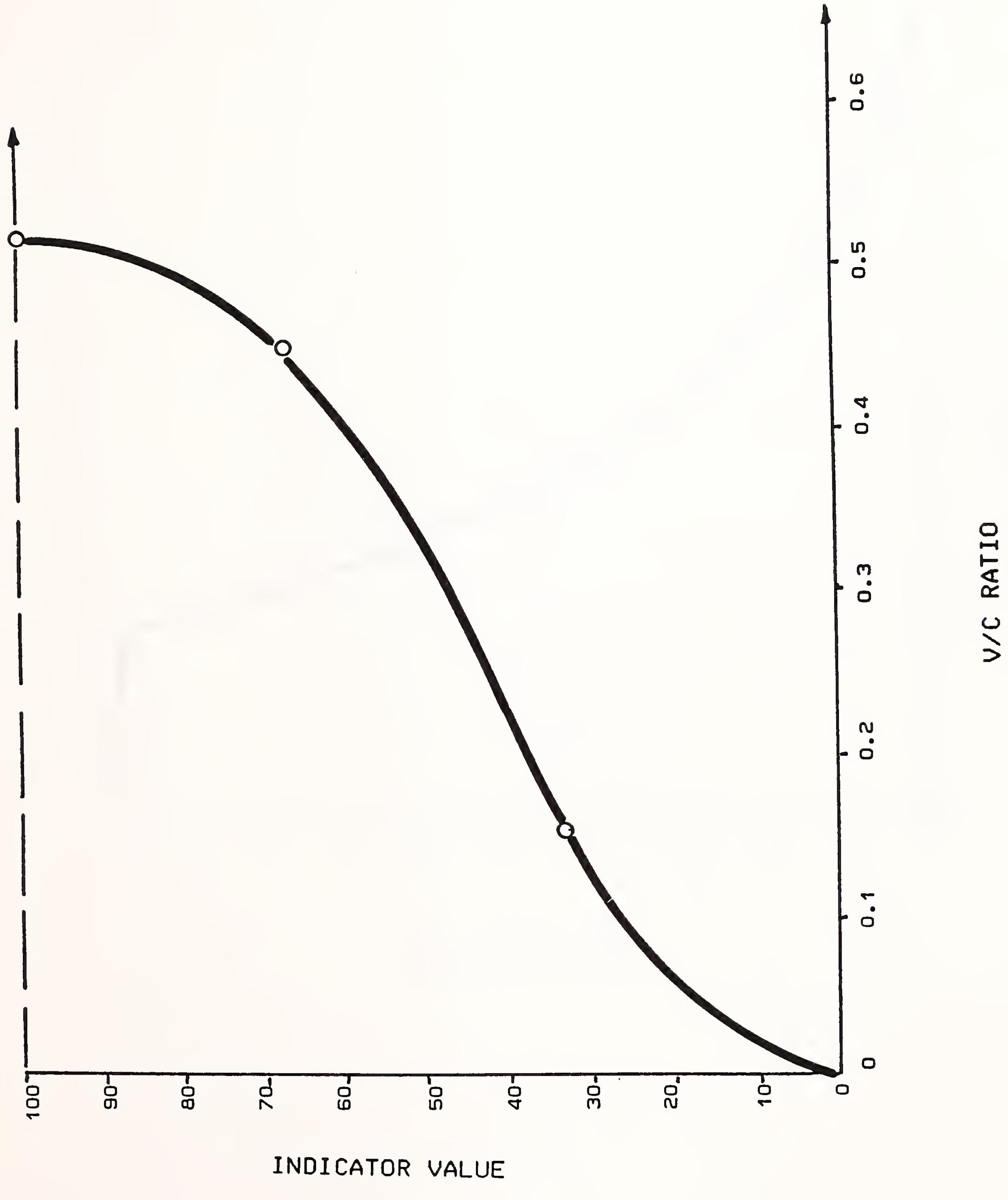


FIGURE 6. V/C RATIO INDICATOR

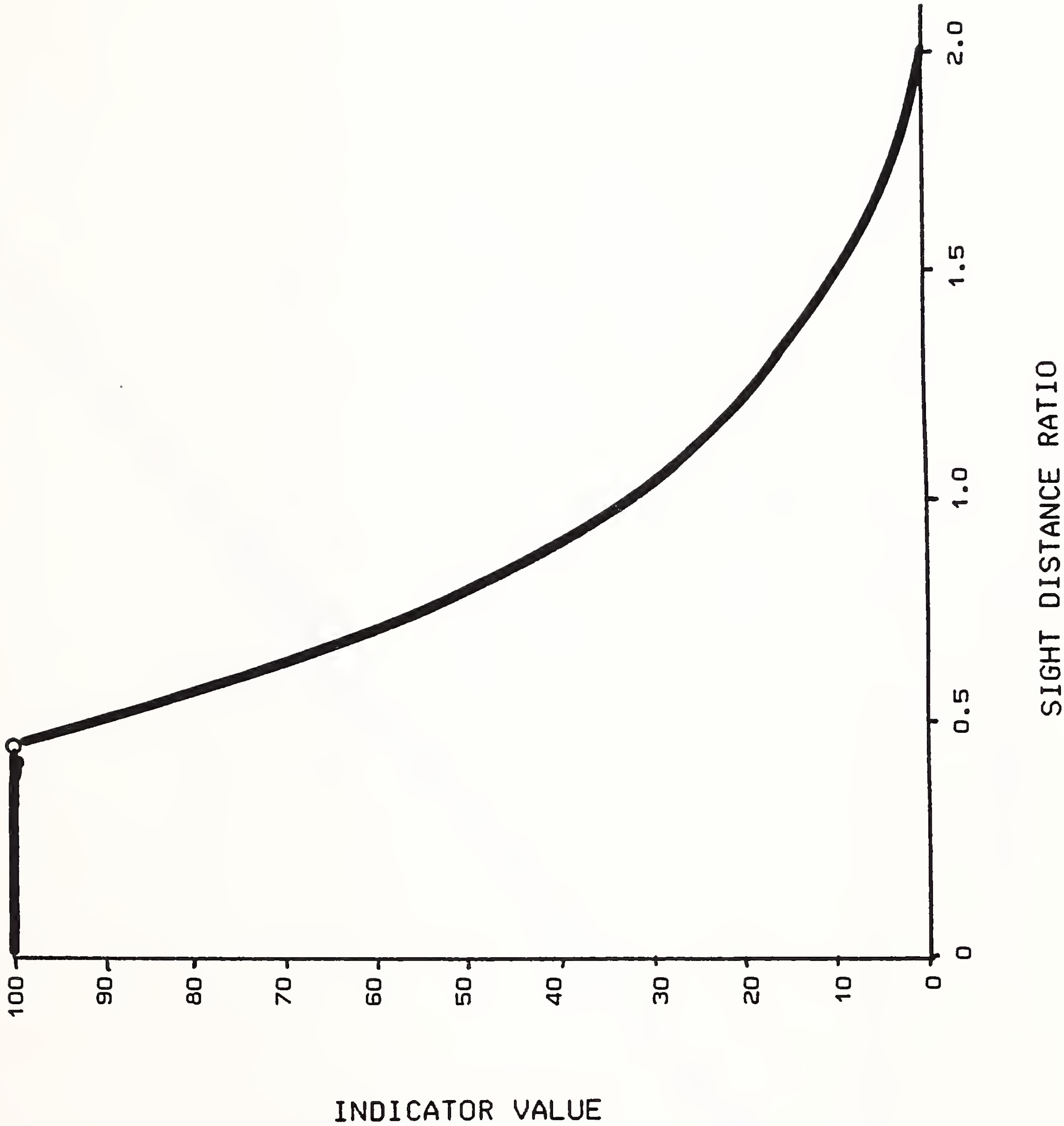


FIGURE 7. SIGHT DISTANCE INDICATOR

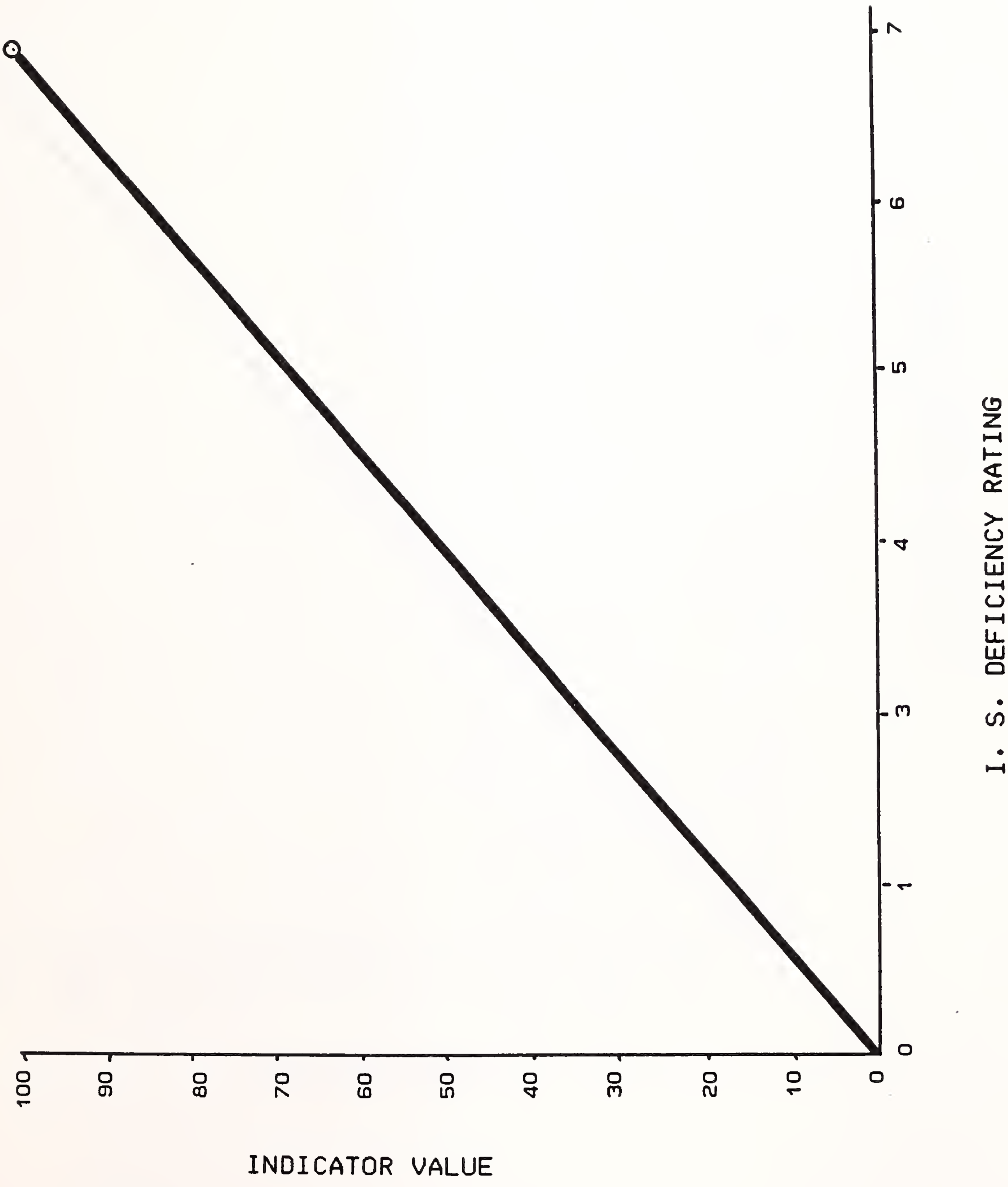


FIGURE 8. INFORMATION DEFICIENCY INDICATOR

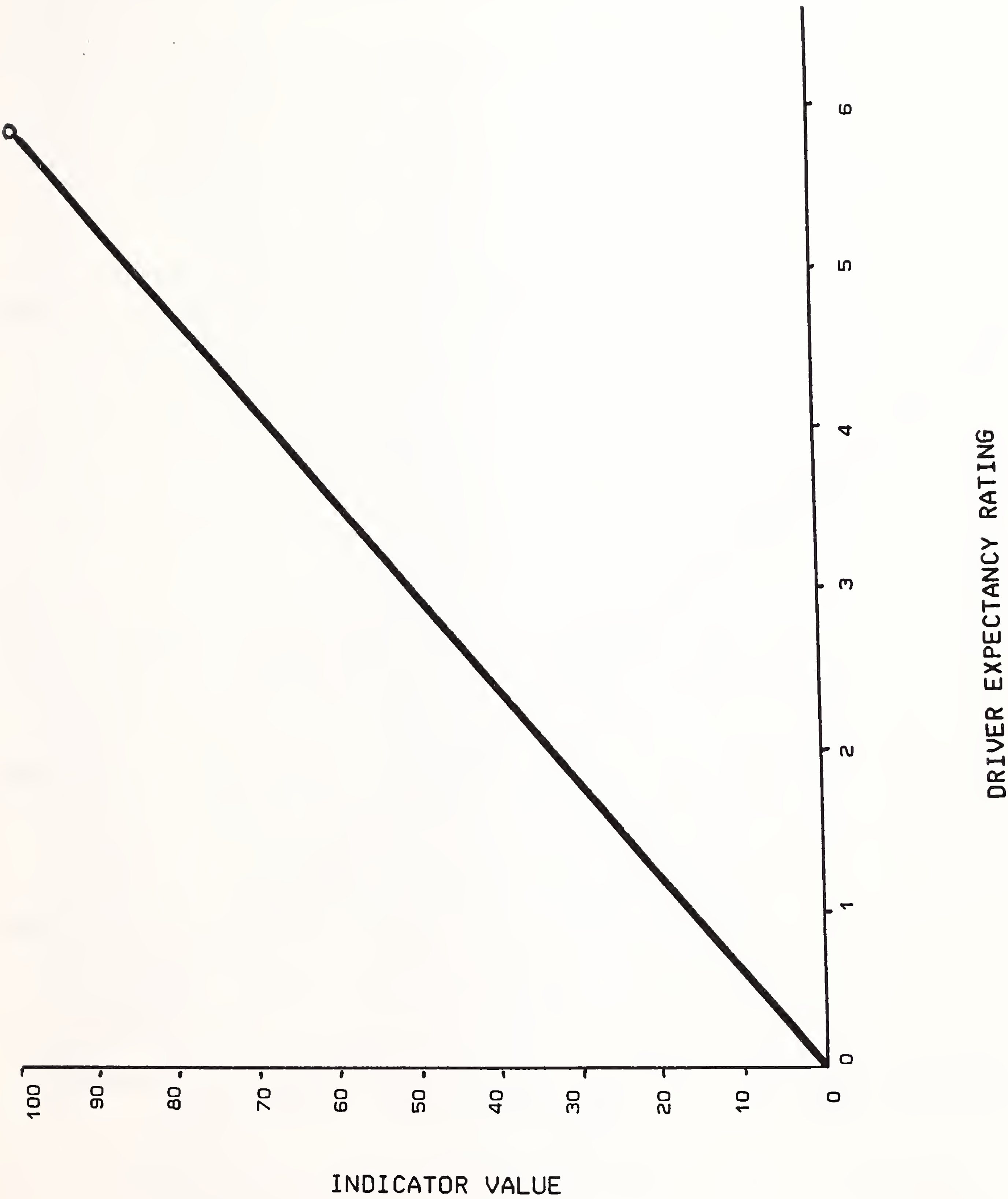


FIGURE 9. DRIVER EXPECTANCY INDICATOR

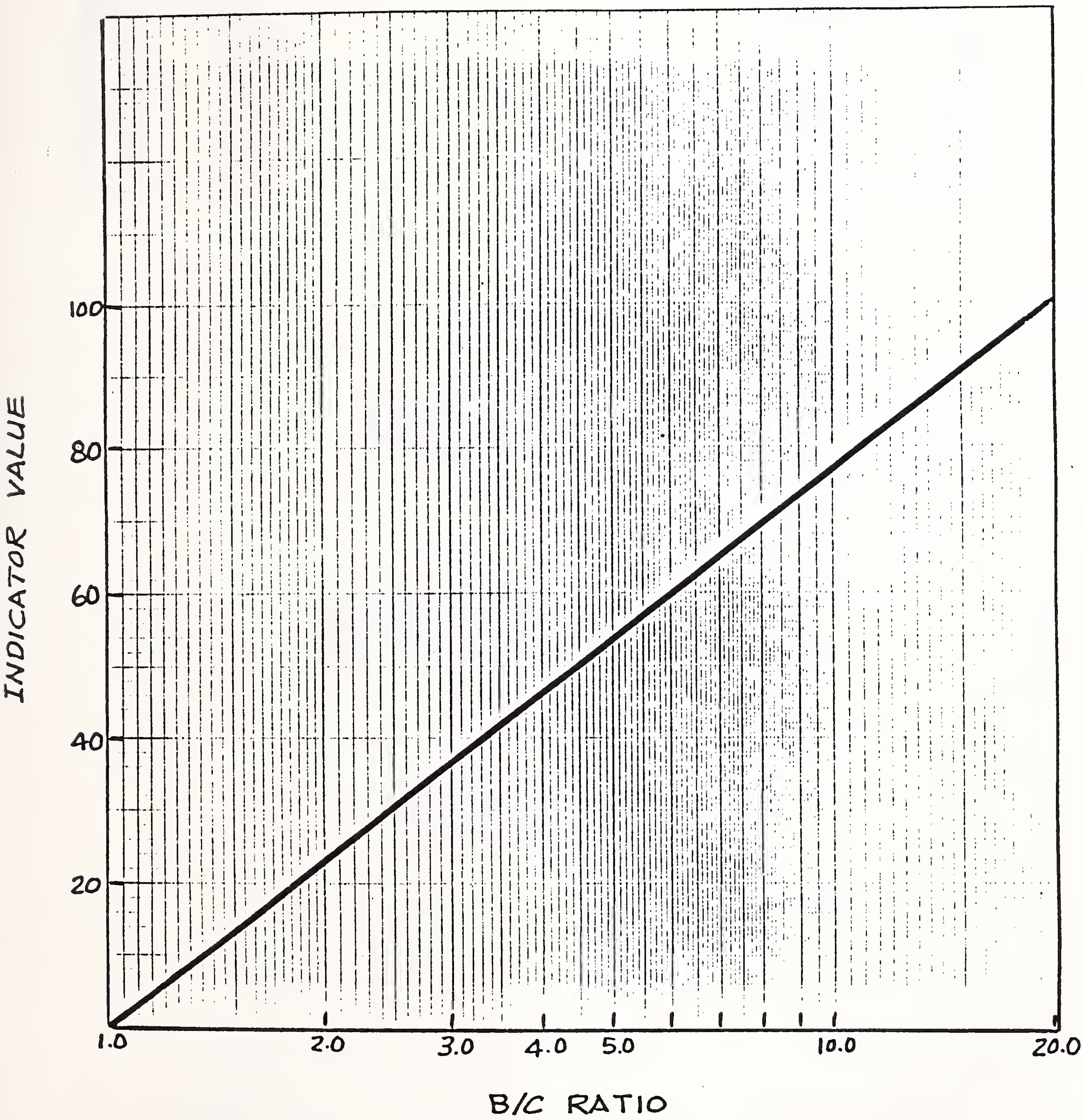


FIGURE 10. BENEFIT/COST RATIO

INDIVIDUAL

SITE ANALYSIS

SECTIONS

SITE #1

ST. MARY'S LAKE ROAD
PRIORITY NUMBER 1

SITE DESCRIPTION

St. Mary's Lake Road is a rural road which provides access to camp sites, farms and recreational areas in the Mission Mountain Range. It begins in St. Ignatius and heads in a southwesterly direction past Lake St. Mary, for a distance of approximately 12 miles until it intersects with Jocko Road near the Middle Fork. The accident cluster area is located approximately 4 miles east of St. Ignatius.

EXISTING CONDITIONS

Geometrics. The site geometrics are shown in the existing condition sketch. Accident cluster areas are spread out among the first series of curves starting at the end of an extended tangent section, which includes a section approximately 0.6 miles in length. The gravel road varies in width from 20 to 28 feet throughout this section. The grade is fairly constant, varying between 1 and 2%. Trees line the roadway and often infringe upon the shoulders. Four to five foot high, grassy roadway backslopes rising from the shoulder of the road along with fences and power lines, occur throughout the section's length.

Traffic Control Devices. The only traffic control devices in this section are hazard markers at the ends of a short section

of guardrail. The markers are not applied correctly since the slash marks are pointed in the wrong direction.

Traffic Volumes. The current traffic volume on this section of roadway is approximately 150. This is the lowest volume roadway of all the study sites. Traffic volumes throughout the past four years have probably remained relatively constant. The directional split on this roadway is approximately 40%-60% which means that at certain periods of the day, 40% of the vehicles are going in one direction while the remainder are headed in the other.

Traffic Operations. No serious conflicts were observed on this section of roadway. Traffic volumes are so low that it is difficult to determine driver and vehicle reaction to the situations encountered. From the Engineer's perspective during subjective evaluations at the site, it was noted that several factors have combined to create potential problems at this site.

1. The roadway geometrics at the first curve site are extreme in comparison to the previous section of tangent road.

2. The gravel road has developed sections of washboard surface that causes loss of control even at low speeds (20-30 MPH). Irrigation sprinklers pump water onto the road surface causing muddy and rutted areas.

3. The high grassy berms, fences and power lines give the feeling of driving in a tunnel. No room for avoidance manuevers

exists. The slightest curve in the roadway restricts sight distance ahead.

4. Road approaches are completely hidden by trees and other vegetation.

Accidents. The collision diagram and accident statistics tables shown on the existing condition sketch indicates that there were seven accidents recorded in the four year study period. There seems to be an increasing trend in the annual number of accidents with 4 occurring in 1988 and only 2 in 1986. All of the accidents were single vehicle accidents. The primary conditions of the accidents was an inability to traverse the roadway alignment with a resulting loss of vehicle control.

The majority of accidents occurred on dry roads in fair weather conditions. The majority of accidents also occurred during daytime driving conditions. Injury type accidents occurred with more frequency than property damage accidents.

SHORT TERM IMPROVEMENTS

Suggested improvements at this site strive to reduce the effects of the above noted problems. Proper curve warning signs, indicating the presence of curves in an otherwise straight road section, will alert drivers to a pending change in the alignment. Delineation along the most critical of the site's curves will provide positive guidance through this portion of road, especially during inclement weather or during nigh time conditions.

Increased maintenance on the road surface will improve control of vehicle dynamics. Cutting trees, trimming brush and mowing grass in the curve areas and at intersections are probably the most critical improvements since it will open the view of the road alignment and of other vehicles.

The cost of these improvements is estimated to be approximately $1,820 based on 1989 unit bid contract prices and MDOH fund eligible prices.

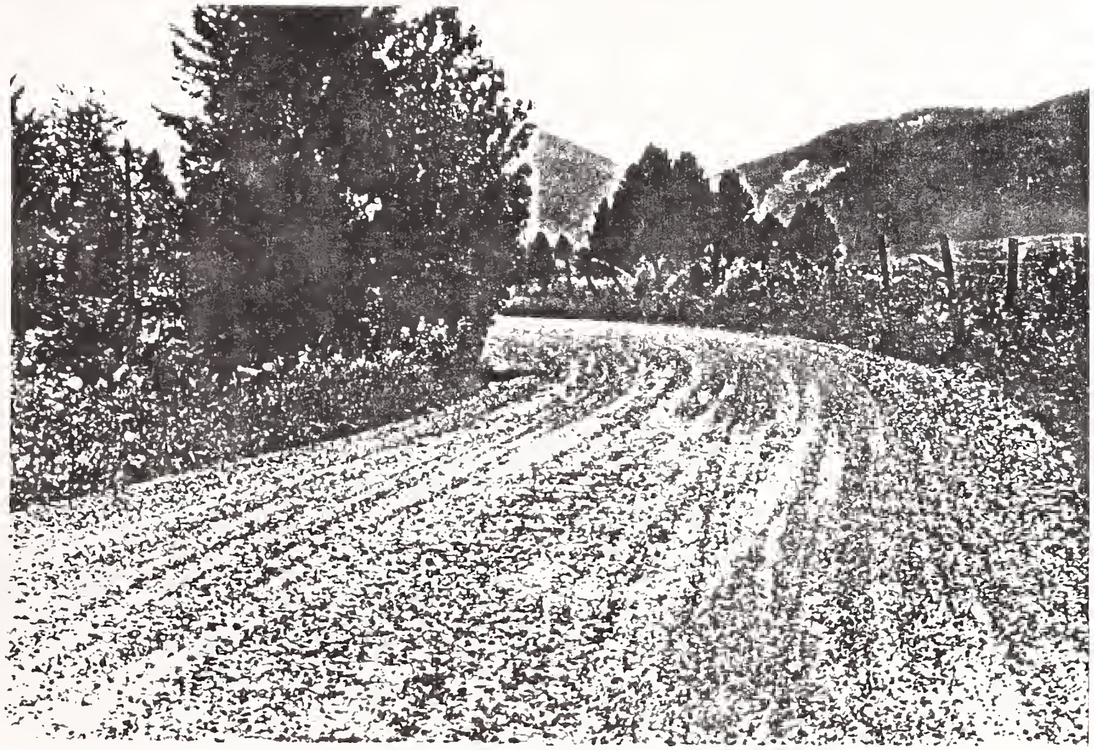
Long term improvements at this site would include regrading the roadside berms, relocating fences and power lines, and straightening small reverse curves. These improvements would probably not be practical with current traffic volumes.

BENEFITS

The annual dollar benefit that may be realized from the short term improvements is computed to be approximately $9,427 annually. The benefit/cost ratio is computed according to accepted methods at 16.25, highest of all the study sites.

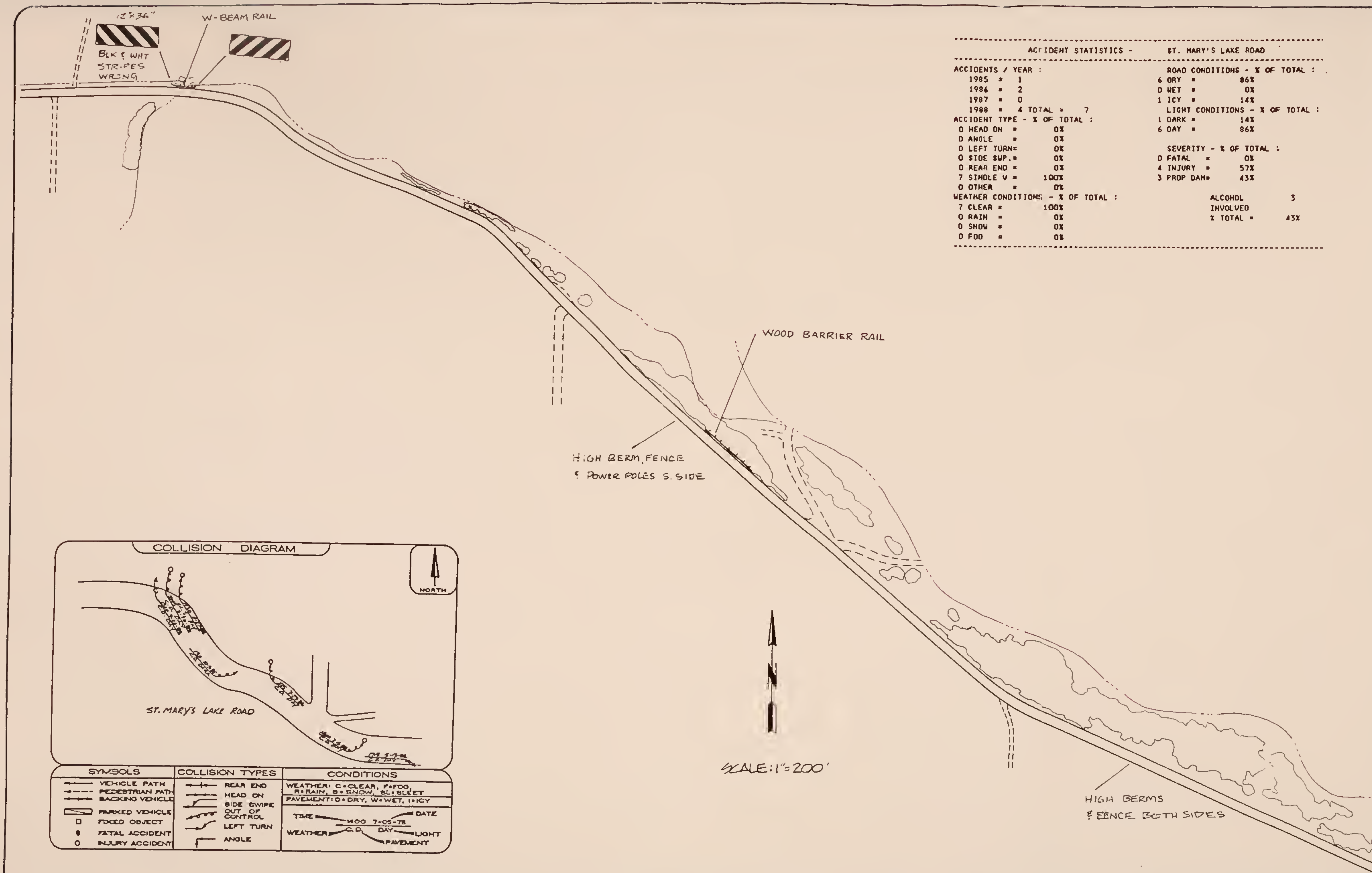
ST. MARYS 1ST CURVE, SOUTHBOUND

ST. MARYS 2ND CURVE, SOUTHBOUND



ST. MARYS 3RD CURVE, SOUTHBOUND

ST. MARYS 3RD CURVE, NORTHBOUND



ACCIDENT STATISTICS - ST. MARY'S LAKE ROAD

ACCIDENTS / YEAR :
- 1985 = 1
- 1986 = 2
- 1987 = 0
- 1988 = 4 TOTAL = 7

ACCIDENT TYPE - % OF TOTAL :

0	HEAD ON =	0%
0	ANGLE =	0%
0	LEFT TURN =	0%
0	SIDE SWP. =	0%
0	REAR END =	0%
7	SINGLE V =	100%
0	OTHER =	0%

WEATHER CONDITIONS - % OF TOTAL :

7	CLEAR =	100%
0	RAIN =	0%
0	SNOW =	0%
0	FOG =	0%

ROAD CONDITIONS - % OF TOTAL :

6	DRY =	86%
0	WET =	0%
1	ICY =	14%

LIGHT CONDITIONS - % OF TOTAL :

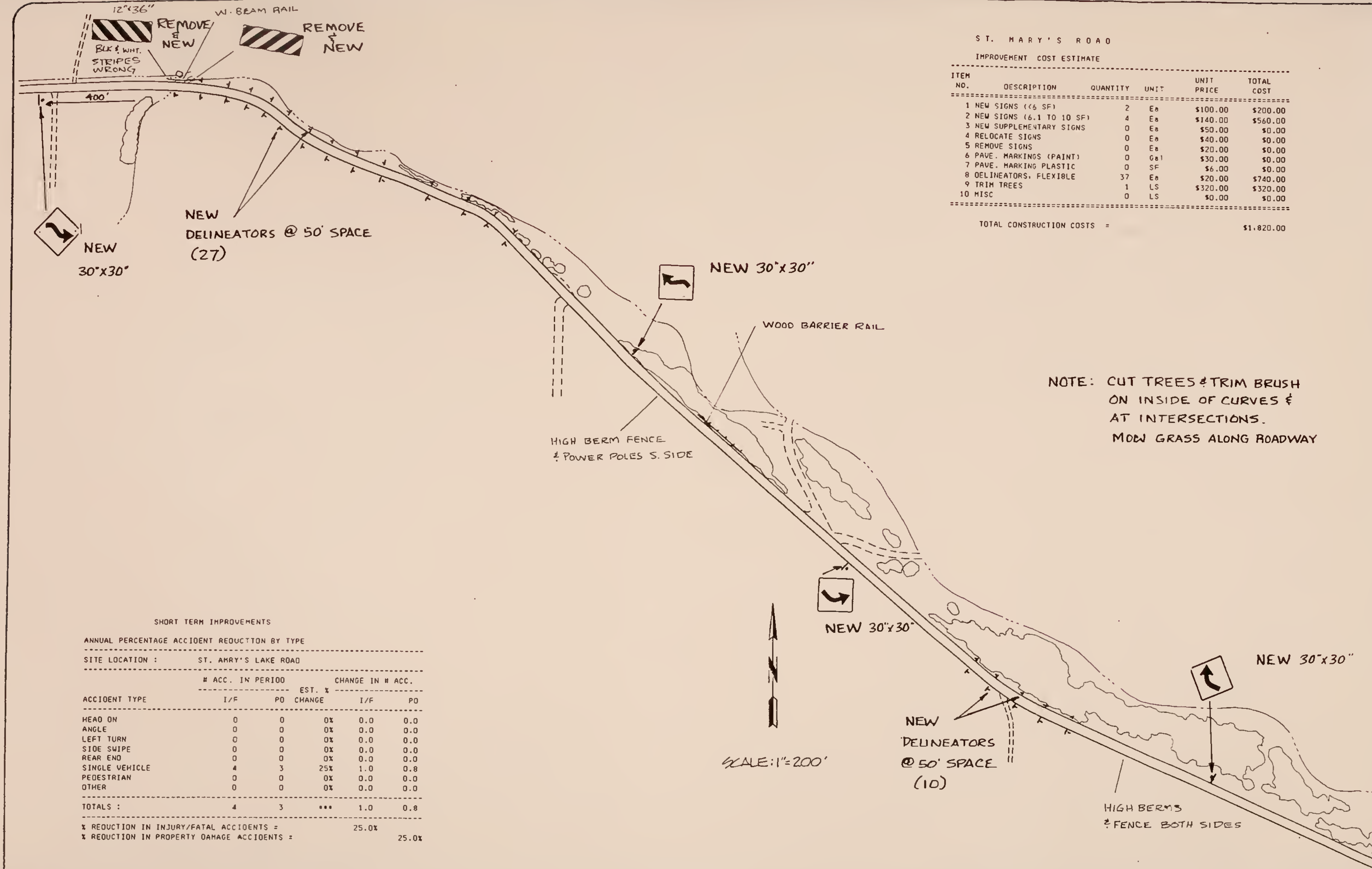
1	DARK =	14%
6	DAY =	86%

SEVERITY - % OF TOTAL :

0	FATAL =	0%
4	INJURY =	57%
3	PROP DAM =	43%

ALCOHOL INVOLVED 3
% TOTAL = 43%

MARVIN & ASSOCIATES Traffic Transportation & Civil Engineers SUITE 304 TRANSWESTERN I 404 N. 31st BILLINGS, MT 59107 Ph. (406) 248-5088	Project : LAKE COUNTY TRAFFIC SAFETY STUDY	Sheet Title : ST. MARY'S ROAD EXISTING CONDITIONS	Surveyed By : Designed By : Drawn By Checked By : Date	Revisions No. Date No. Date No. Date No. Date	Project No Client No	Sheet No. 1 of



S T. M A R Y ' S R O A D

IMPROVEMENT COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	NEW SIGNS (<6 SF)	2	Ea	$100.00	$200.00
2	NEW SIGNS (6.1 TO 10 SF)	4	Ea	$140.00	$560.00
3	NEW SUPPLEMENTARY SIGNS	0	Ea	$50.00	$0.00
4	RELOCATE SIGNS	0	Ea	$40.00	$0.00
5	REMOVE SIGNS	0	Ea	$20.00	$0.00
6	PAVE. MARKINGS (PAINT)	0	Gal	$30.00	$0.00
7	PAVE. MARKING PLASTIC	0	SF	$6.00	$0.00
8	DELINEATORS, FLEXIBLE	37	Ea	$20.00	$740.00
9	TRIM TREES	1	LS	$320.00	$320.00
10	MISC	0	LS	$0.00	$0.00

TOTAL CONSTRUCTION COSTS = $1,820.00

NOTE: CUT TREES & TRIM BRUSH ON INSIDE OF CURVES & AT INTERSECTIONS. MOW GRASS ALONG ROADWAY

SHORT TERM IMPROVEMENTS

ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : ST. AMRY'S LAKE ROAD

	# ACC. IN PERIOD		EST. %	CHANGE IN # ACC.	
ACCIDENT TYPE	I/F	PD	CHANGE	I/F	PD
HEAD ON	0	0	0%	0.0	0.0
ANGLE	0	0	0%	0.0	0.0
LEFT TURN	0	0	0%	0.0	0.0
SIDE SWIPE	0	0	0%	0.0	0.0
REAR END	0	0	0%	0.0	0.0
SINGLE VEHICLE	4	3	25%	1.0	0.8
PEDESTRIAN	0	0	0%	0.0	0.0
OTHER	0	0	0%	0.0	0.0
TOTALS :	4	3	***	1.0	0.8

% REDUCTION IN INJURY/FATAL ACCIDENTS = 25.0%
% REDUCTION IN PROPERTY DAMAGE ACCIDENTS = 25.0%

MARVIN & ASSOCIATES
Traffic Transportation & Civil Engineers
SUITE 304 TRANSWESTERN I
404 N. 31st
BILLINGS, MT 59107
Ph. (406) 245-5088

Project: LAKE COUNTY TRAFFIC SAFETY STUDY

Sheet Title: ST. MARY'S ROAD SHORT TERM IMPROVEMENTS

Surveyed By: ____ Designed By: ____ Drawn By: ____ Checked By: ____ Date: ____

Revisions: No. ____ Date ____

Project No. ____ Card No. ____

Sheet No. 1 of ____

SITE #2

OLD U.S. 93 - CANYON MILL
PRIORITY NUMBER 2

SITE DESCRIPTION

Old U.S. 93 is a north-south road which used to be part of the Highway 93 alignment before Highway 93 was reconstructed to by-pass certain towns within Lake County. This section of Old U.S. 93 is approximately 2.0 miles north of Ronan, Montana. It serves as alternate access between Pablo and Ronan; as an access to local farms and residences; and as a collector road between rural east-west roads.

The accident cluster area begins approximately 1.8 miles north of Ronan and includes a section approximately 0.6 miles in length.

EXISTING CONDITIONS

Geometrics. The site geometrics are shown in the existing condition sketch. Accident cluster areas are located at the curves in the otherwise tangent roadway. The major cluster area is in the middle of the first curve north of Ronan and involves the intersection of Canyon Mill Road.

The roadway is paved 24 feet in width and has variable shoulder widths and ditch slopes. The section includes a reverse curve. Superelevation of the road surface in the curve sections is variable due to settlement and other conditions of the roadway cross section.

There are two main access points to Old U.S. 93 and both of them are in the middle of the curved alignment. Canyon Mill Road is the only approach road with significant traffic volumes.

Grades along this section are relatively flat and no apparent vertical curves exists. Vegetation growth at this intersection presents only moderate sight distance restrictions. However, ground vegetation along the roadway is tall enough when combined with the high berm on the inside of the first curve to effectively block the roadway alignment from view.

The approach roads have gravel surfaces with the gravel abutting the paved shoulder of Old U.S. 93. Alternate vehicle paths to the roadway have been created by vehicle taking short cuts to the highway over the years.

Traffic Control Devices. The only traffic control devices in this section are stop signs at the road approaches, and some delineators which were probably left over from the time it was a primary highway route. There is also one curve warning sign for the first curve in the northbound direction.

Traffic Volumes. The current traffic volume on this section of roadway is approximately 1,586 vehicles per day. Traffic volumes throughout the past four years have probably increased by approximately 3%. Machine recording counts were taken at this location. The hourly variations indicate that traffic patterns on this road are extremely unusual. The peak hour is at 8:00 in the evening at 12% of average daily traffic. The second highest peak

is at 4:00 in the afternoon with 10% of ADT. Two other peaks are at 12:00 midnight and at 10:00 in the morning. Traffic has extreme variations between these peaks. This indicates that there may be some specific type of traffic using this facility that involves shift work or some other highly intensive attraction. Traffic volumes on Canyon Mill Road are approximately 300 ADT. The directional split on Old U.S. 93 is approximately 40%-60% which means that at certain periods of the day, 40% of the vehicles are going in one direction while the remainder are headed in the other.

Traffic Operations. Some potential conflicts were observed on this section of roadway during the field review. Also, from the Engineer's perspective during subjective evaluations at the site, it was noted that several factors have combined to create potential problems at this site.

1. The curves in the alignment presents a significantly different change in the otherwise straight alignment of the roadway. Even though the curvature of the road is not hidden by vertical curves or roadside conditions, inattentive drivers would be mildly surprised, especially at night.

2. The variation in superelevation in the middle of the curves tends to rock the vehicle. In an emergency situation, this action could be enough to cause loss of control.

3. The stop sign for the westbound approach on Canyon Mill Road is hidden in advance by a large tree. the tree also tends to obscure the surface of Old U.S. 93 from view.

4. With the intersecting roadway in the middle of a curve, it is difficult to tell exactly where the approach road is.

5. Sight distance from the eastbound approach road is blocked to the south by a high roadway berm and grassy slope.

Accidents. The collision diagram and accident statistics tables shown on the existing condition sketch indicates that there were eight accidents recorded in the four year study period. The accidents seem to reflect the conditions encountered at the site. The majority of accidents are single vehicle accidents consistent with loss of control on the curves. Two angle accidents at the Canyon Mill intersection could have been caused by sight restrictions. One accident involved a vehicle and a bike at the intersection.

The majority of accidents occurred on dry roads in fair weather conditions. Accidents occurred mostly during the day time hours. The accidents all occurred between late summer and mid fall in the morning and evening hours, which may indicate some problem with lighting or traffic variations. The severity of accidents at this site is quite high with 63% of the accidents producing injuries.

SHORT TERM IMPROVEMENTS

Suggested improvements at this site strive to reduce the effects of the above noted problems. Over sized curve warning signs are considered necessary to draw more attention in advance

of the curves. Proper delineation of the roadway path is especially critical at this site. Pavement markings combined with delineators will over come the other physical roadway alignment miscues under most circumstances.

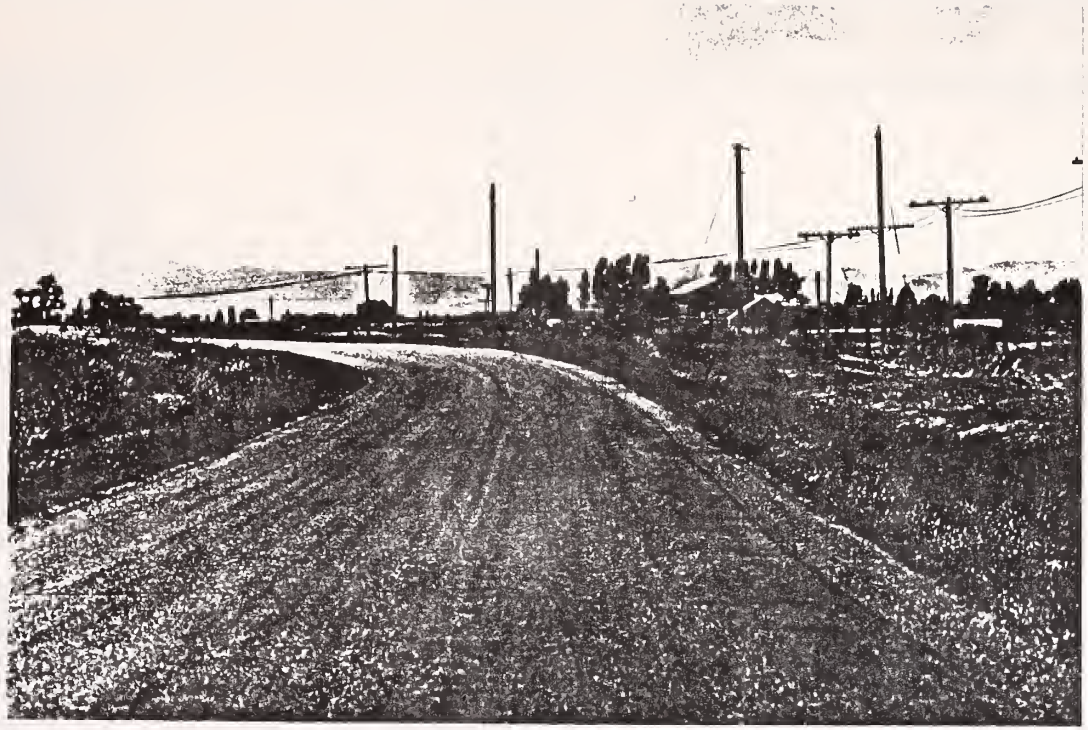
Removal of key trees, bushes and vegetation and grading the earth berms to give motorists an unimpeded view of the road alignment and approaching traffic as viewed from the side roads will decrease the potential risk for entering traffic. Advanced intersection warning and oversized stop signs will better define the intersection control for side road traffic. Use of supplementary road name plates on the advanced intersection warning signs, as provided for in the M.U.T.D.C. will greatly aid drivers in recognizing the location of the approach and in planning the turning maneuver.

The cost of these improvements is estimated to be approximately $5,030 based on 1989 unit bid contract prices and MDOH fund eligible prices. The grading and pavement markings should be much less if county crews performed the work and the striping were to be completed as part of a county wide pavement marking program.

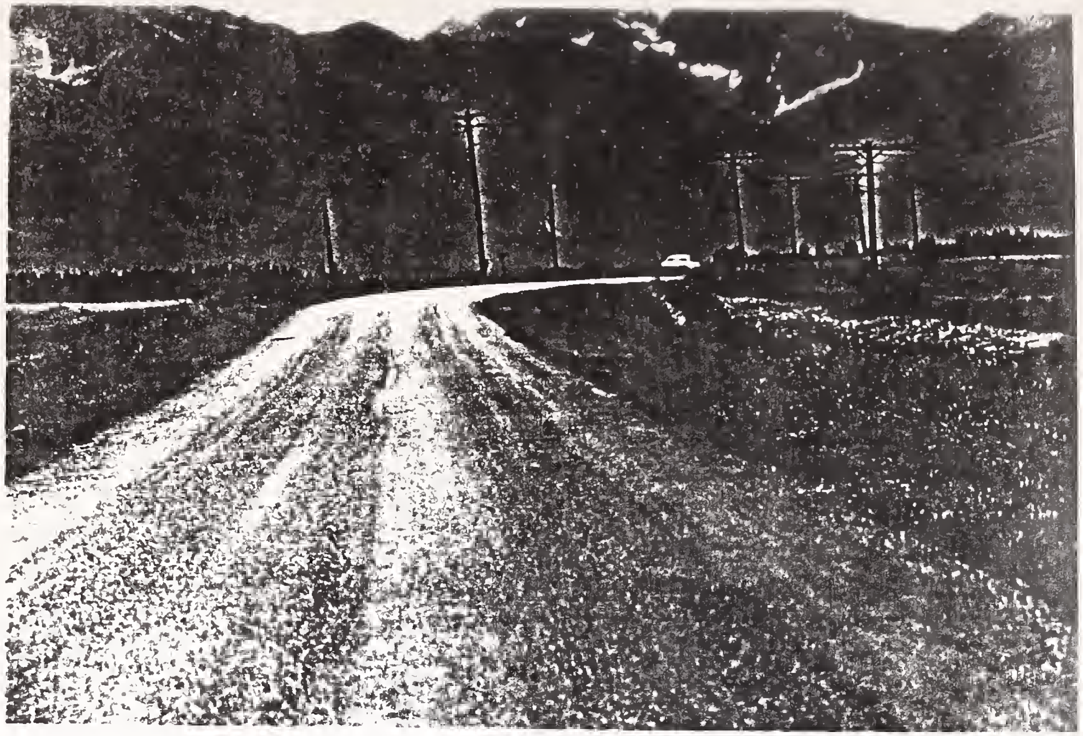
Long term improvements at this site cannot be foreseen nor should they be anticipated until traffic volumes increase beyond 4,000 ADT.

BENEFITS

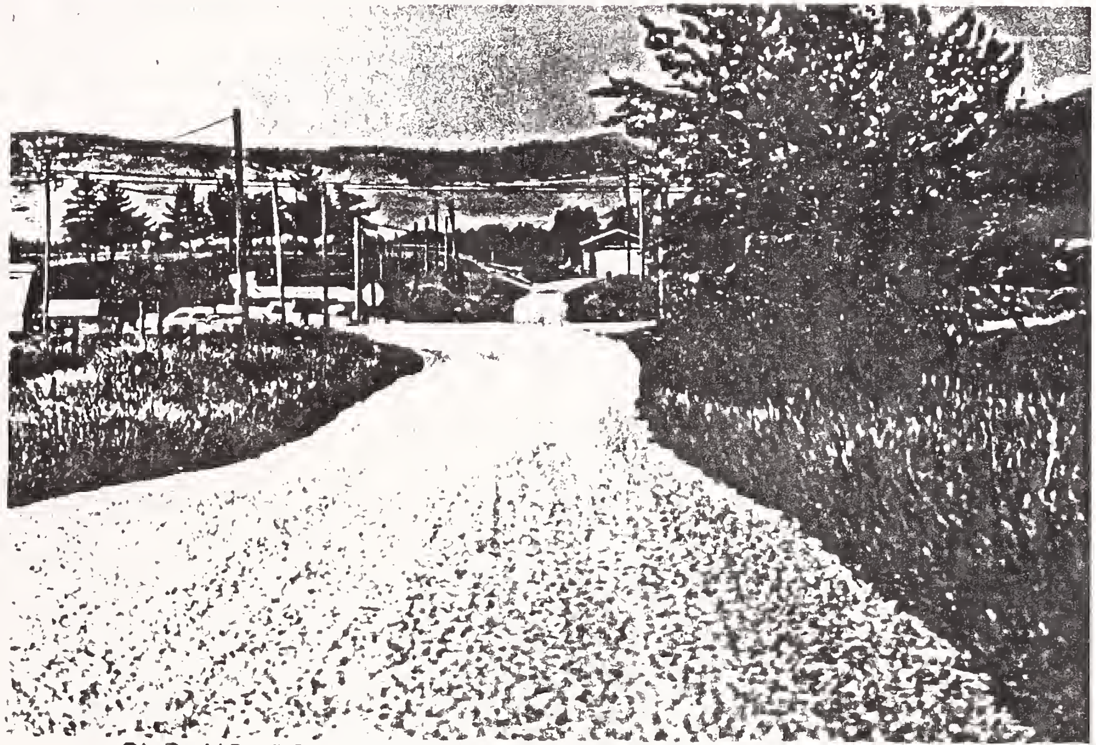
The annual dollar benefit that may be realized from the short term improvements is computed to be approximately $17,825 annually. The benefit/cost ratio is computed according to accepted methods at 12.07, second highest of all study sites.



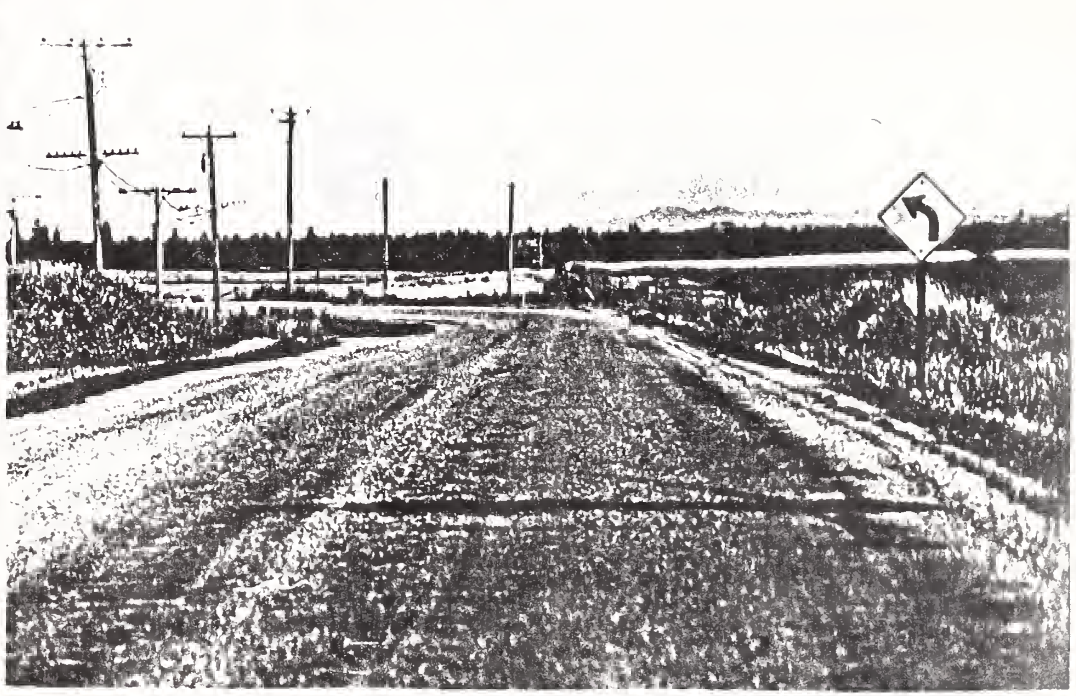
OLD US 93 1ST CURVE, SOUTHBOUND



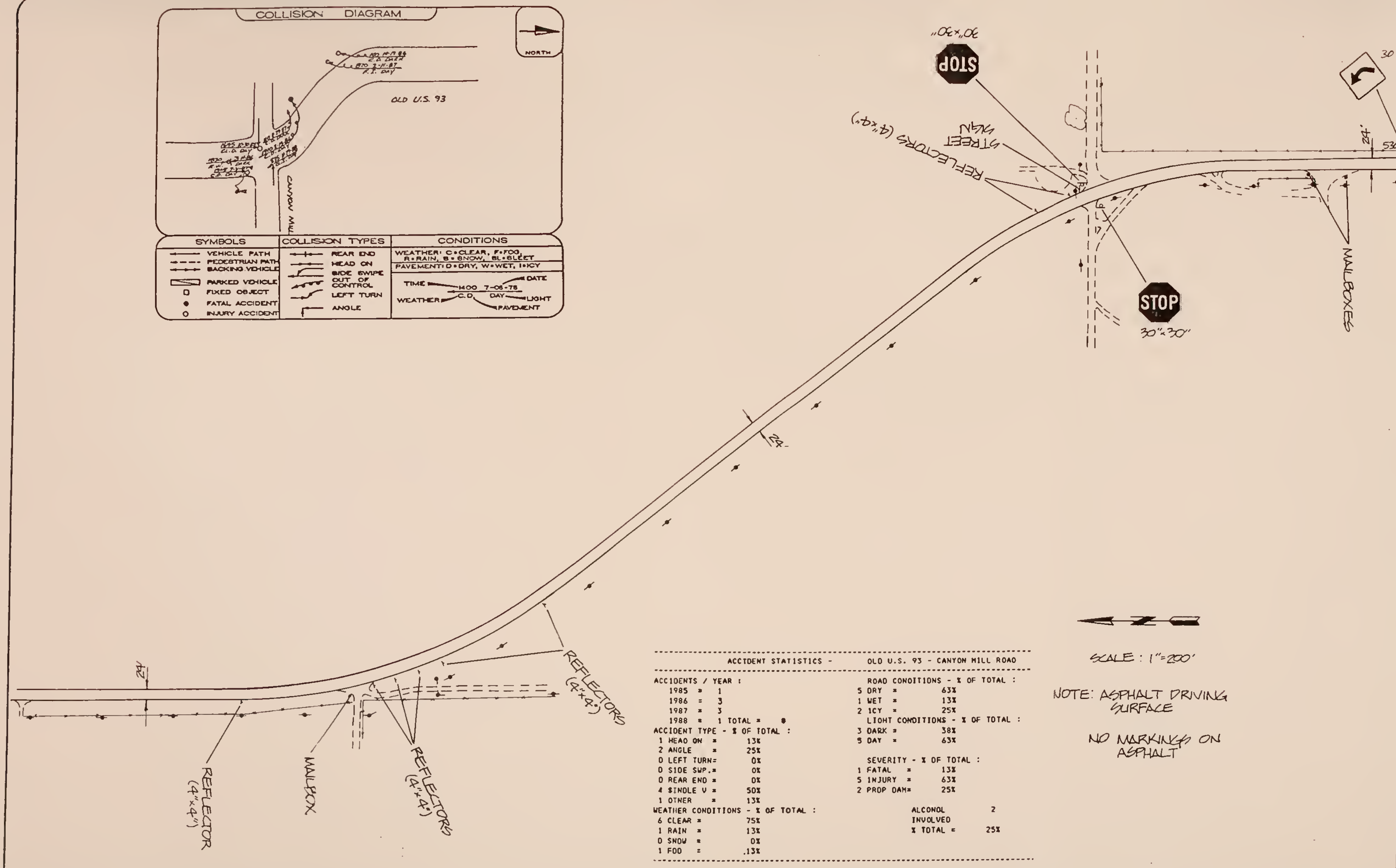
OLD US 93 CURVE @ CANYOM MILL, SOUTHBOUND



OLD US 93 CANYON MILL APP, WESTBOUND



OLD US 93 CURVE @ CANYON MILL, NORTHBOUND



ACCIDENT STATISTICS - OLD U.S. 93 - CANYON MILL ROAD

ACCIDENTS / YEAR :
1985 = 1
1986 = 3
1987 = 3
1988 = 1 TOTAL = 8

ACCIDENT TYPE - % OF TOTAL :
1 HEAD ON = 13%
2 ANGLE = 25%
0 LEFT TURN= 0%
0 SIDE SWP.= 0%
0 REAR END = 0%
4 SINGLE V = 50%
1 OTHER = 13%

WEATHER CONDITIONS - % OF TOTAL :
6 CLEAR = 75%
1 RAIN = 13%
0 SNOW = 0%
1 FOG = .13%

ROAD CONDITIONS - % OF TOTAL :
5 DRY = 63%
1 WET = 13%
2 ICY = 25%

LIGHT CONDITIONS - % OF TOTAL :
3 DARK = 38%
5 DAY = 63%

SEVERITY - % OF TOTAL :
1 FATAL = 13%
5 INJURY = 63%
2 PROP DAM= 25%

ALCOHOL INVOLVED 2
% TOTAL = 25%

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BILLINGS, MT 59107
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Project : LAKE COUNTY TRAFFIC SAFETY STUDY

Sheet Title : OLD U.S. 93 - CANYON MILL RD EXISTING CONDITIONS

Surveyed By :
Designed By :
Drawn By
Checked By :
Date :

Revisions
No. Date
No. Date
No. Date
No. Date

Project No.
Client No.

Sheet No. 1 of

OLD US 93 - CANYON HILL

IMPROVEMENT COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	NEW SIGNS (<6 SF)	16	Ea	$100.00	$1,600.00
2	NEW SIGNS (6.1 TO 10 SF)	8	Ea	$140.00	$1,120.00
3	NEW SUPPLEMENTARY SIGNS	2	Ea	$50.00	$100.00
4	RELOCATE SIGNS	5	Ea	$20.00	$100.00
5	REMOVE SIGNS	3	Ea	$20.00	$60.00
6	PAVE. MARKINGS (PAINT)	50	Gal	$25.00	$1,250.00
7	PAVE. MARKING PLASTIC	0	SF	$6.00	$0.00
8	DELINEATORS, FLEXIBLE	0	Ea	$20.00	$0.00
9	TRIM TREES	320	LS	$0.00	$0.00
10	GRADING & PAVING & MISC	1	LS	$800.00	$800.00

TOTAL CONSTRUCTION COSTS = $5,030.00

SHORT TERM IMPROVEMENTS

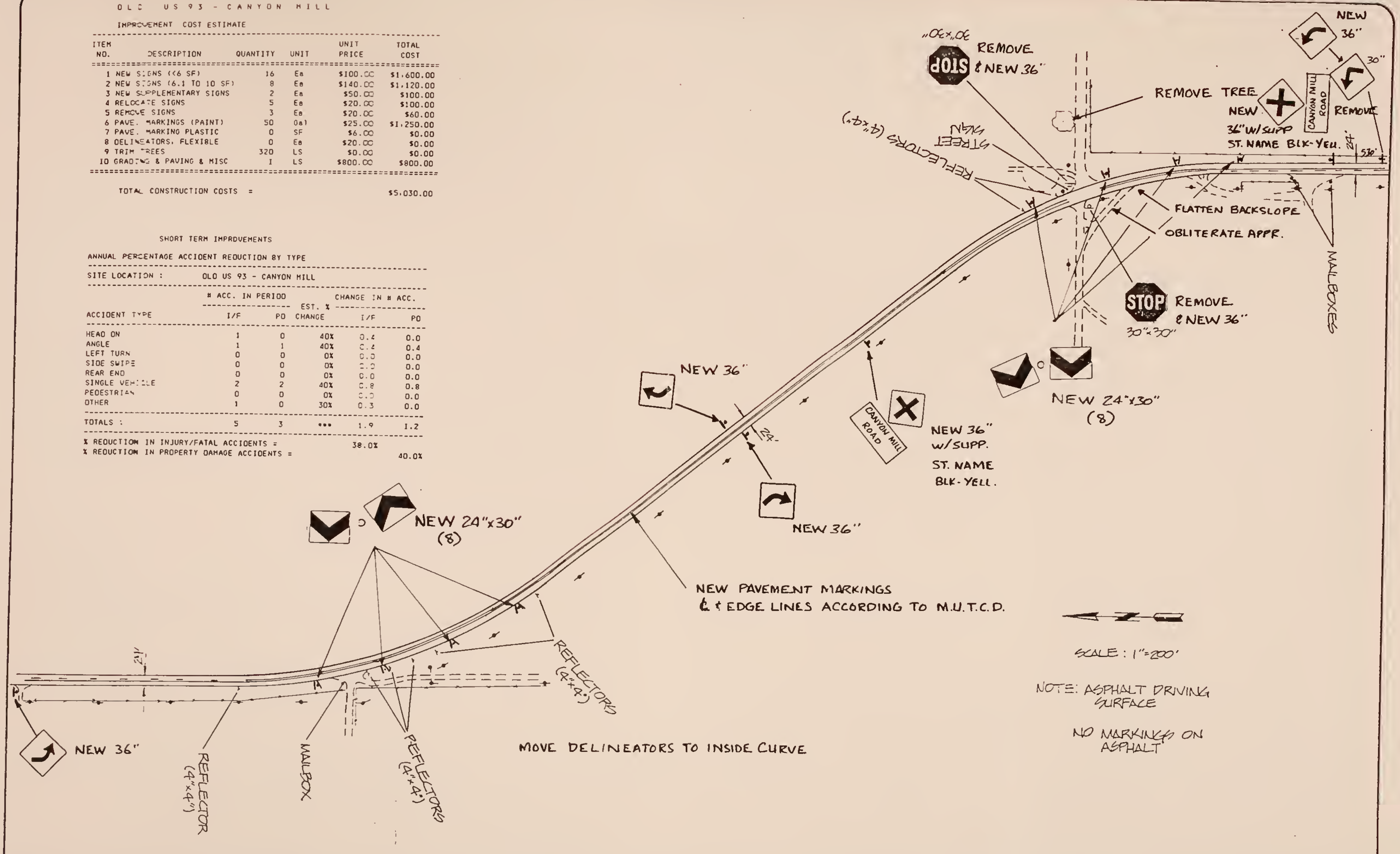
ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : OLD US 93 - CANYON HILL

ACCIDENT TYPE	# ACC. IN PERIOD I/F	# ACC. IN PERIOD PD	EST. % CHANGE	CHANGE IN # ACC. I/F	CHANGE IN # ACC. PD
HEAD ON	1	0	40%	0.4	0.0
ANGLE	1	1	40%	0.4	0.4
LEFT TURN	0	0	0%	0.0	0.0
SIDE SWIPE	0	0	0%	0.0	0.0
REAR END	0	0	0%	0.0	0.0
SINGLE VEHICLE	2	2	40%	0.8	0.8
PEDESTRIAN	0	0	0%	0.0	0.0
OTHER	1	0	30%	0.3	0.0
TOTALS :	5	3	***	1.9	1.2

% REDUCTION IN INJURY/FATAL ACCIDENTS = 38.0%

% REDUCTION IN PROPERTY DAMAGE ACCIDENTS = 40.0%



MARVIN & ASSOCIATES Traffic Transportation & Civil Engineers SUITE 304 TRANSWESTERN I 404 N. 31st BILLINGS, MT 59107 Ph. (406) 248-5066	Project : LAKE COUNTY TRAFFIC SAFETY STUDY	Sheet Title : OLD U.S. 93 - CANYON MILL RD SHORT TERM IMPROVEMENTS	Surveyed By : Designed By : Drawn By : Checked By : Date : Revisions No. Date No. Date No. Date No. Date Project No. Client No. Sheet No. 1 of

SITE #3

TIMBERLANE ROAD @ 1.0 MILES
PRIORITY NUMBER 3

SITE DESCRIPTION

Timberlane Road is an east-west rural type road which begins at U.S. 93, one mile south of Ronan, and extends west along section and mid section lines to an intersection with Terrace Lake Road 3.0 miles east of Ronan. It provides access to farms, rural residences and other land uses along its length.

Their were five accidents cluster sites identified on Timberlane Road. Two of the accident sites were selected by Lake County for study. During the course of the study it became apparent that all of the sites were similar in geometrics and accident experience. Therefore, all of the cluster areas were incorporated into the two study sites. This site includes a section of road approximately 1.2 Miles in length. The exact limits of this site are shown on the existing condition sketch.

EXISTING CONDITIONS

Geometrics. The site geometrics are shown in the existing condition sketch. Accident cluster areas are located on the tangent section prior to the first curve and at the two 90 degree curves included in the site. The roadway has 22 to 24 foot wide pavement and has variable shoulder widths and ditch slopes. Vertical grades at this site are flat. The roadside environment is primarily heavy timber with forest and meadow type vegetation.

There are also power poles, grassed embankments, fences, mailboxes and drive approaches throughout its length.

Traffic Control Devices. There are four turn signs existing at this site. One of the curve signs is nonstandard, since it has the words "Sharp Turn" printed on the sign sign face. Two of the signs are not appropriately placed for the speed of the facility (35mph). A speed limit sign also exists at the site, but it is in poor condition. No pavement markings are visible in the area.

Traffic Volumes. The current traffic volume on this section of roadway is approximately 350 vehicles per day. Traffic volumes throughout the past four years have probably increased by approximately 4% or more. The County could not provide historical counts at this site. The directional split on this roadway is approximately 40%-60% which means that at certain periods of the day, 40% of the vehicles are going in one direction while the remainder are headed in the other.

Traffic Operations. Potential vehicle operations problems were observed on this section of roadway during the field review. From the Engineer's perspective during subjective evaluations at the site, it was noted that several additional factors could create potential problems at this site.

1. The curve sections are the only deviations from tangent on the entire route. The turns are sharp 90 degrees corners which requires a significant decrease in speed to negotiate. The curves

have a Ballbank reading of 12 degrees at 20 mph. While the paved tangent sections could reasonable carry traffic at an average speed in excess of 45 mph. Adequate attention is not given to this situation.

2. Sight distance at the curve is severely impeded by trees and other vegetation growing within the inside of the curve.

3. Location of drive approaches in the middle of the curves adds to potential conflicts in these areas. Mailboxes located in these areas intensifies the conflict.

4. Although the roadway is paved, there are areas of extreme roughness which causes vehicle control problems.

5. The 35 mph speed zone seems unrealistic when the road-side environment, pavement surface and low traffic volumes are considered. A speed survey should be conducted to determine the proper speed limits.

Accidents. The collision diagram and accident statistics tables shown on the existing condition sketch indicates that there were nine accidents recorded in the four year study period. The accidents seem to be increasing, since there were four in 1988 alone. The type of accidents primarily involved single vehicle accidents with one fixed object and one car-bike accident.

The majority of accidents occurred in fair weather conditions and on dry roads. Accidents occurred predominantly during the daytime hours. The severity of accidents at this site is high, with the majority being injury type accidents.

SHORT TERM IMPROVEMENTS

Suggested improvements at this site strive to reduce the effects of the above noted problems. Over-sized curve warning signs are considered necessary 500 feet in advance of the curves to provide adequate warning of the severe curvature conditions. Advisory speed plates are critical for these curves.

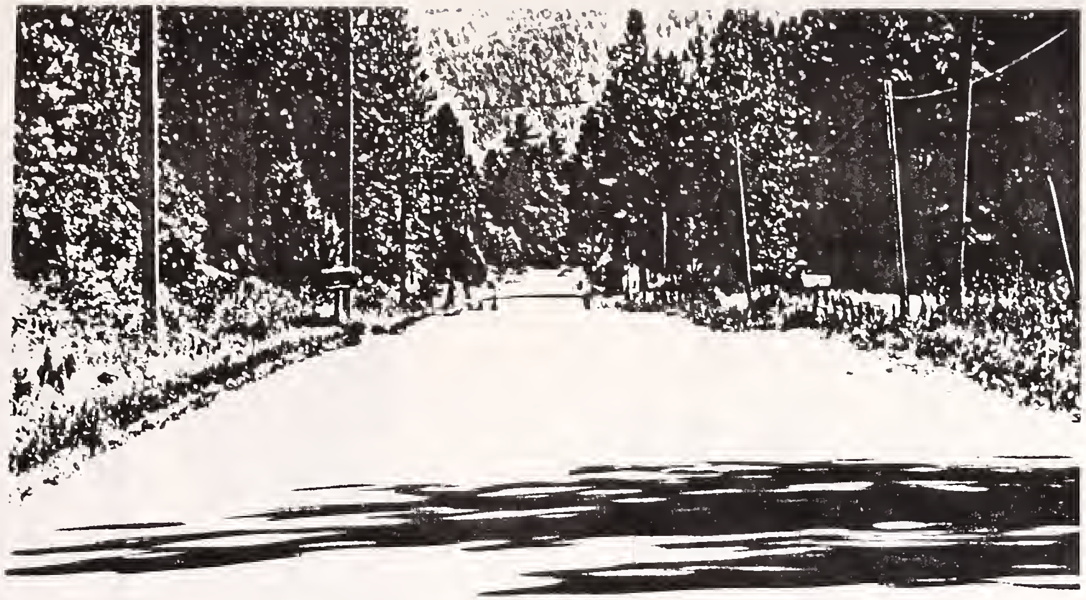
Proper delineation of the roadway path is especially critical at the curves. However, the curves are so sharp that the arrow panel sign is the only devices that could be reasonably applied. Pavement markings are extremely desirable at this site to provide visual information on the roadway alignment, assign proper lanes and delineate safe passing zones. Speed limit signs should be located past the curves for the desired direction of travel only. The busiest of these approaches should have a stop control sign and mailboxes should be relocated to an area which does not require vehicles to stop near the road surface in the middle of the curves. Removal of vegetation on the inside of corners and at key points along the roadway will provide the most important improvements by allowing drivers more time to anticipate and react.

The cost of these improvements is estimated to be approximately $4,790 based on 1989 unit bid contract prices and MDOH fund eligible prices. The pavement markings should be much less if county crews performed the work and the striping were to be completed as part of a county wide pavement marking program.

Long term improvements at this site would involve reconstructing the curves to provide a design speed of at least 35 mph. Access control in these curves could then be controlled better. The long term improvement should be considered necessary when traffic volumes exceed 2,000 ADT.

BENEFITS

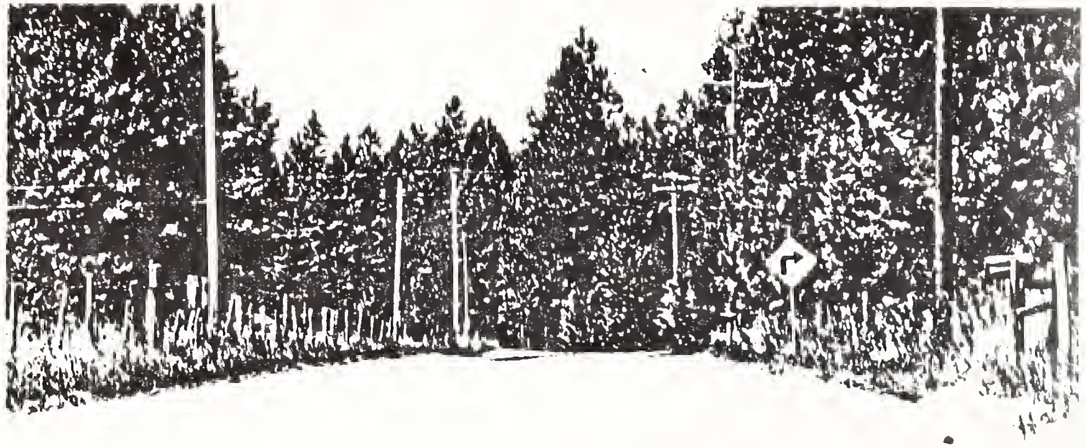
The annual dollar benefit that may be realized from the short term improvements is computed to be approximately $15,161 annually. The benefit/cost ratio is computed to be 11.12 according to methods developed by the Montana Department of Highways. This is the third highest of all the sites.



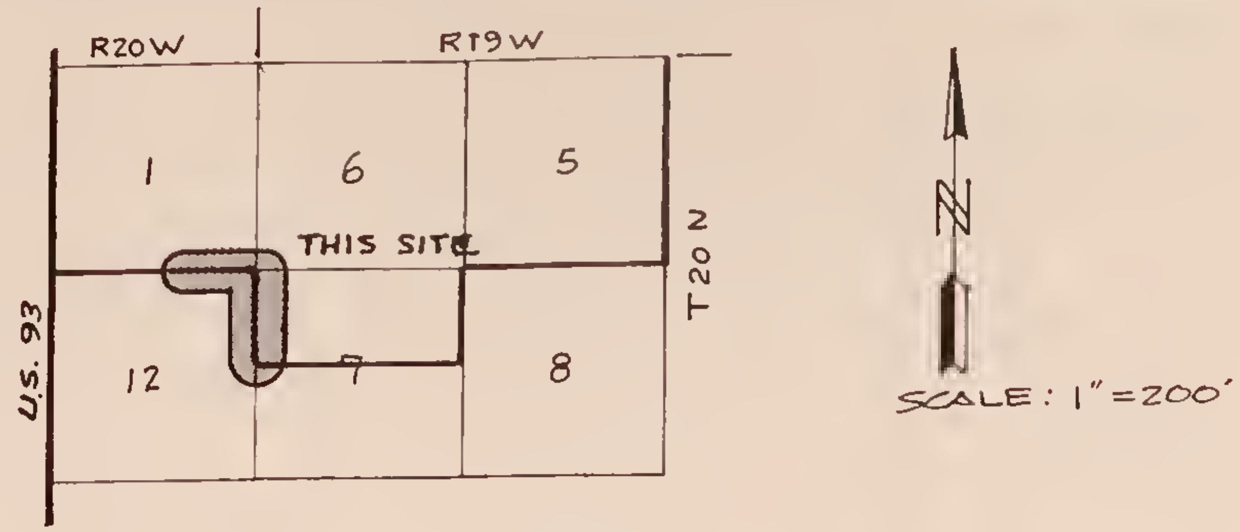
TIMBERLANE RD. @.7 MILES E, EASTBOUND

TIMBERLANE RD. CURVE @ 1 MILE, EASTBOUND

TIMBERLANE RD. CURVE @ 1 MILE, NORTHBOUND



TIMBERLANE RD. CURVE @ 1.5 MILE, WESTBOUND

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ACCIDENT STATISTICS -        TIMBERLANE ROAD - 1.0 MILES EAST

ACCIDENTS / YEAR :                        ROAD CONDITIONS - % OF TOTAL :
   1985  =   2                            8 DRY   =        89%
   1986  =   1                            0 WET   =         0%
   1987  =   2                            1 ICY   =        11%
   1988  =   4 TOTAL =    9                 LIGHT CONDITIONS - % OF TOTAL :
ACCIDENT TYPE - % OF TOTAL :              3 DARK =         33%
 0 HEAD ON   =       0%                   6 DAY  =         67%
 0 ANGLE     =       0%
 0 LEFT TURN=        0%                     SEVERITY - % OF TOTAL :
 0 SIDE SWP.=        0%                   0 FATAL    =      0%
 0 REAR END =        0%                   5 INJURY   =     56%
 7 SINGLE V =       78%                   4 PROP DAM=      44%
 2 OTHER    =       22%
WEATHER CONDITIONS - % OF TOTAL :               ALCOHOL       4
 8 CLEAR =          89%                         INVOLVED
 0 RAIN  =           0%                         % TOTAL =    44%
 1 SNOW  =          11%
 0 FOG   =           0%
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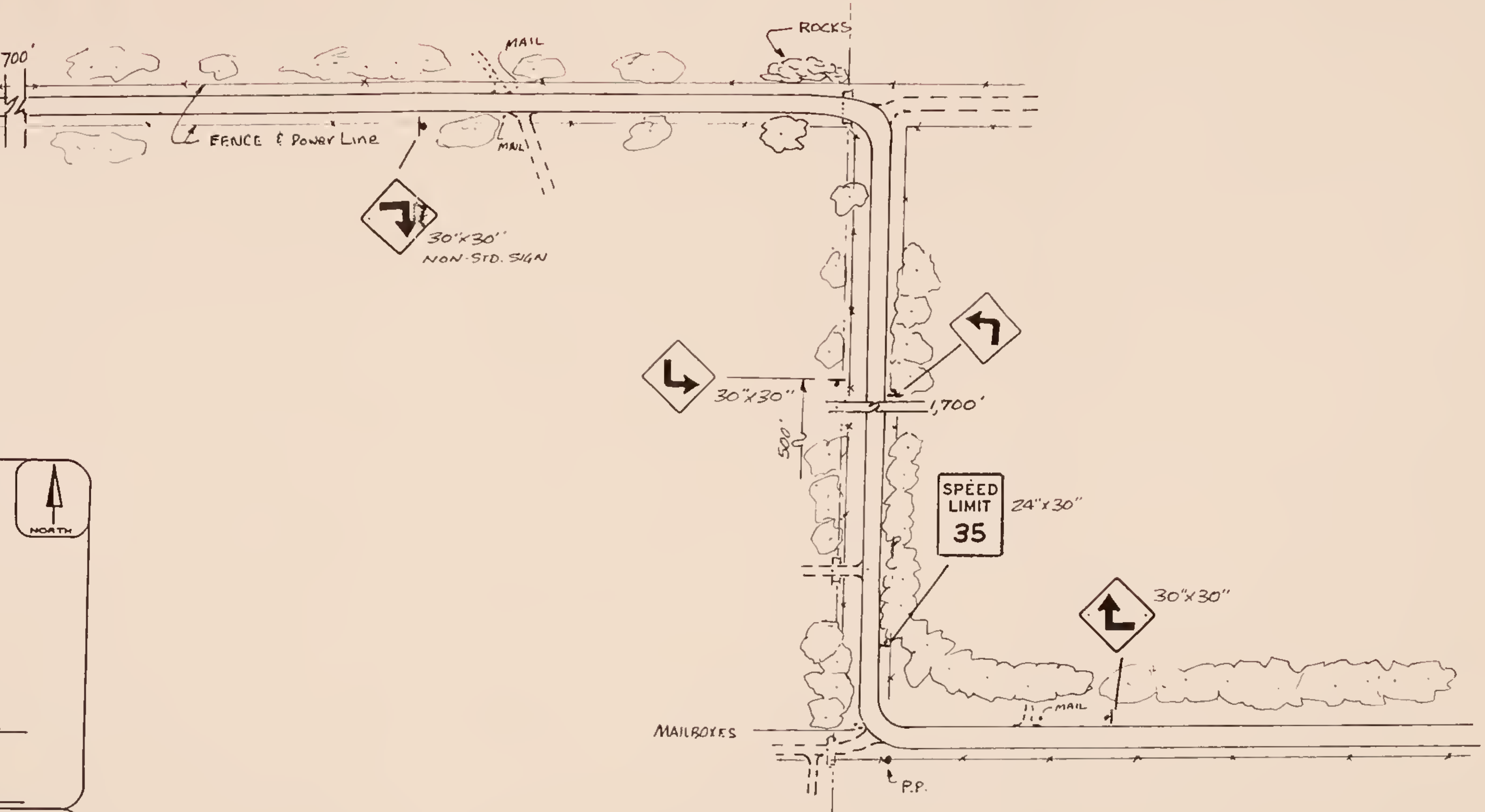
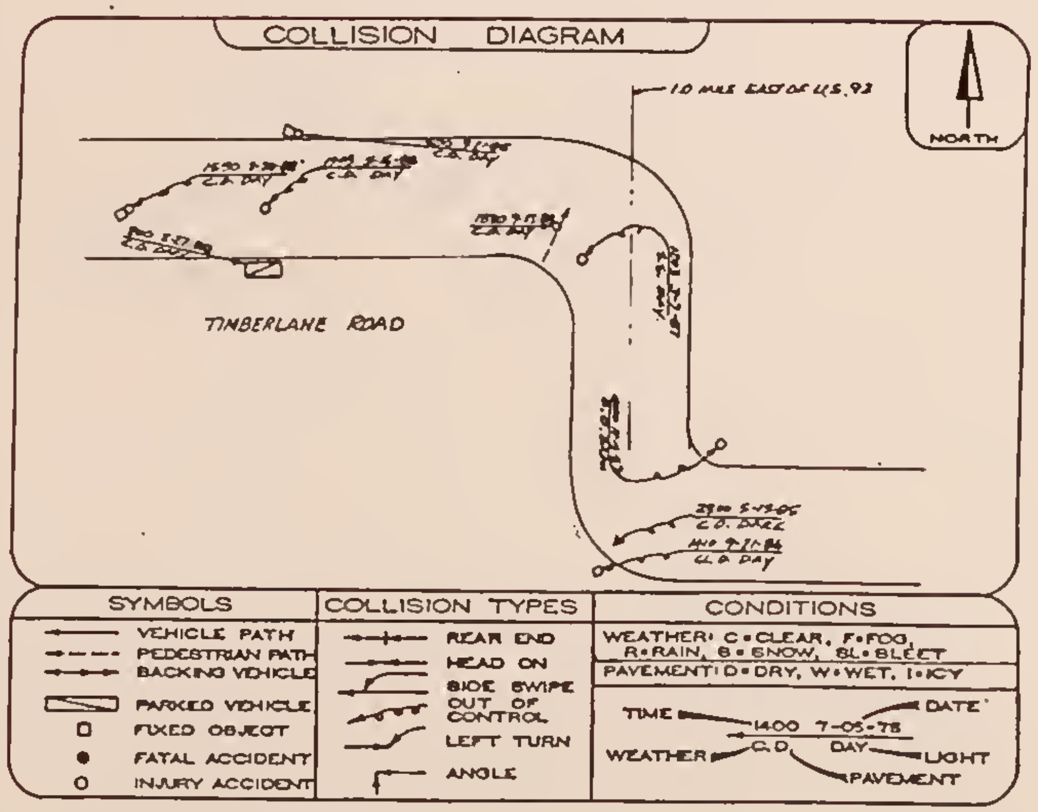
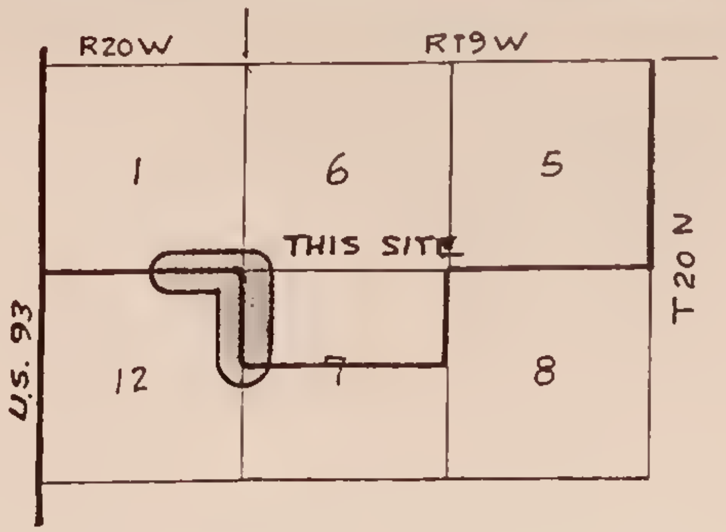
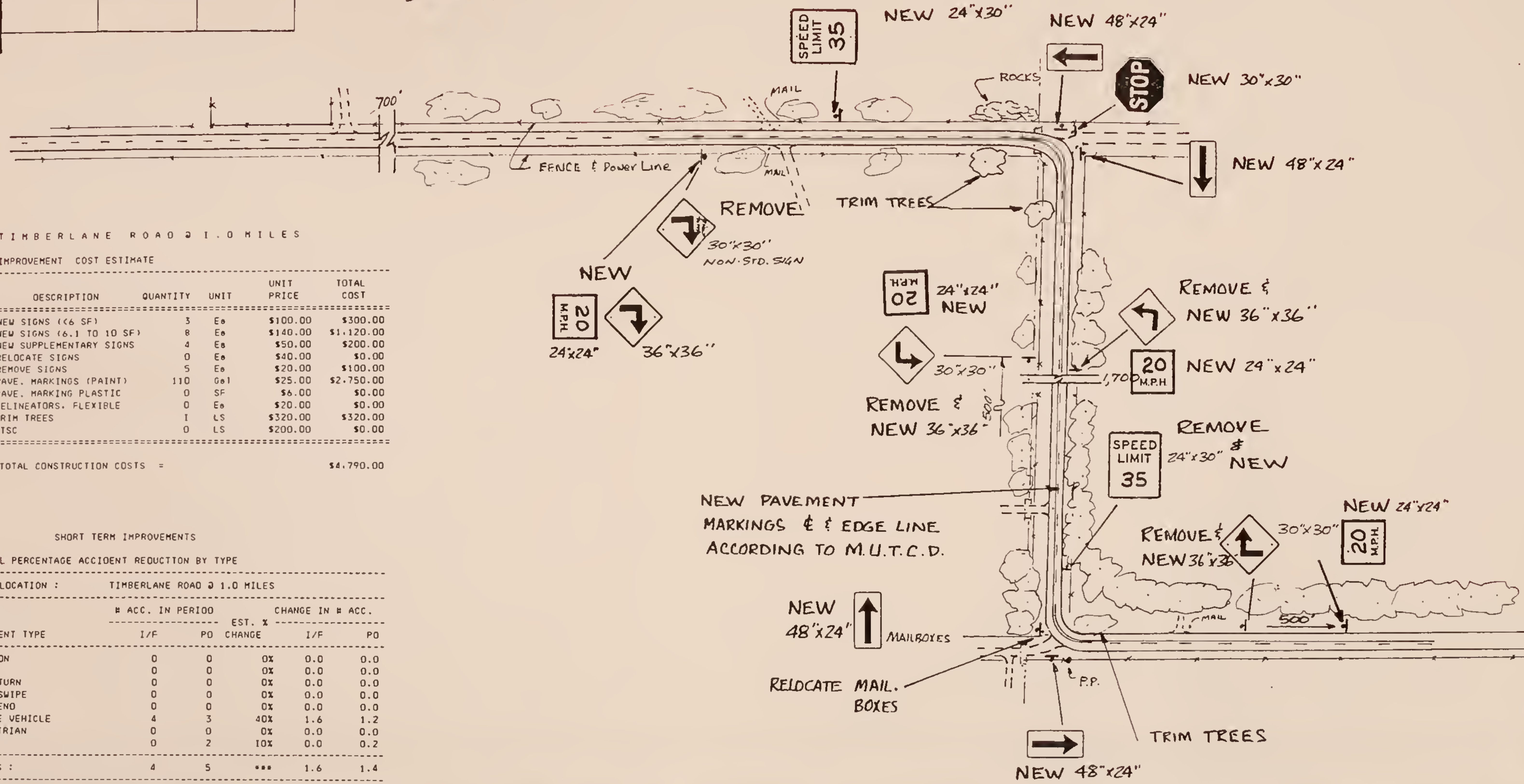




MARVIN & ASSOCIATES Traffic Transportation & Civil Engineers	SUITE 304 TRANSWESTERN I 404 N. 31st BILLINGS, MT 59107 Ph. (406) 248-6088	Project: LAKE COUNTY TRAFFIC SAFETY STUDY	Sheet Title: TIMBERLANE ROAD - 1.0 MILES EXISTING CONDITIONS	Surveyed By: Designed By: Drawn By: Checked By: Date:	Revisions No. Date No. Date No. Date No. Date	Project No. Client No.	Sheet No. 1 of





T I M B E R L A N E R O A D @ 1 . 0 M I L E S

IMPROVEMENT COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	NEW SIGNS (<6 SF)	3	Ea	$100.00	$300.00
2	NEW SIGNS (6.1 TO 10 SF)	8	Ea	$140.00	$1,120.00
3	NEW SUPPLEMENTARY SIGNS	4	Ea	$50.00	$200.00
4	RELOCATE SIGNS	0	Ea	$40.00	$0.00
5	REMOVE SIGNS	5	Ea	$20.00	$100.00
6	PAVE. MARKINGS (PAINT)	110	Gal	$25.00	$2,750.00
7	PAVE. MARKING PLASTIC	0	SF	$6.00	$0.00
8	DELINEATORS, FLEXIBLE	0	Ea	$20.00	$0.00
9	TRIM TREES	1	LS	$320.00	$320.00
10	MISC	0	LS	$200.00	$0.00

TOTAL CONSTRUCTION COSTS = $4,790.00

SHORT TERM IMPROVEMENTS

ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : TIMBERLANE ROAD @ 1.0 MILES

ACCIDENT TYPE	# ACC. IN PERIOD I/F	# ACC. IN PERIOD PD	EST. % CHANGE	CHANGE IN # ACC. I/F	CHANGE IN # ACC. PD
HEAD ON	0	0	0%	0.0	0.0
ANGLE	0	0	0%	0.0	0.0
LEFT TURN	0	0	0%	0.0	0.0
SIDE SWIPE	0	0	0%	0.0	0.0
REAR END	0	0	0%	0.0	0.0
SINGLE VEHICLE	4	3	40%	1.6	1.2
PEDESTRIAN	0	0	0%	0.0	0.0
OTHER	0	2	10%	0.0	0.2
TOTALS :	4	5	***	1.6	1.4

% REDUCTION IN INJURY/FATAL ACCIDENTS = 40.0%

% REDUCTION IN PROPERTY DAMAGE ACCIDENTS = 28.0%

MARVIN & ASSOCIATES
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Project : LAKE COUNTY TRAFFIC SAFETY STUDY

Sheet Title : TIMBERLANE ROAD - 1.0 MILES SHORT TERM IMPROVEMENTS

Surveyed By :
Designed By :
Drawn By :
Checked By :
Date :

Revisions
No. Date
No. Date
No. Date
No. Date

Project No.

Client No.

Sheet No. 1 of

SITE #4

TIMBERLANE ROAD @ 2.5 MILES
PRIORITY NUMBER 4

SITE DESCRIPTION

Timberlane Road is an east-west rural type road which begins at U.S. 93, one mile south of Ronan, and extends west along section and mid section lines to an intersection with Terrace Lake Road 3.0 miles east of Ronan. It provides access to farms, rural residences and other land uses along its length.

Their were five accidents cluster sites identified on Timberlane Road. Two of the accident sites were selected by Lake County for study. During the course of the study it became apparent that all of the sites were similar in geometrics and accident experience. Therefore, all of the cluster areas were incorporated into the two study sites. This site includes a section of road approximately 1.9 Miles in length. The exact limits of this site are shown on the existing condition sketch.

EXISTING CONDITIONS

Geometrics. The site geometrics are shown in the existing condition sketch. Accident cluster areas are located on the three 90 degree curves included in the site. The roadway has 22 to 24 foot wide pavement and variable shoulder widths and ditch slopes. Vertical grades at this site are flat. The roadside environment is primarily heavy timber with forest and meadow type

vegetation. There are also power poles, grassed embankments, fences, mailboxes and drive approaches throughout its length.

Traffic Control Devices. There are six turn warning signs existing at this site. All of these signs are not appropriately placed for the speed of the facility (35mph). One of the signs is barely 200 feet in advance of the curve. Two speed limit signs also exist at this site. These signs are located just ahead of the curve signs. No pavement markings are visible in the area.

Traffic Volumes. The current traffic volume on this section of roadway is approximately 300 vehicles per day. Traffic volumes throughout the past four years have probably increased by approximately 4% or more. The County could not provide historical counts at this site. The directional split on this roadway is approximately 40%-60% which means that at certain periods of the day, 40% of the vehicles are going in one direction while the remainder are headed in the other.

Traffic Operations. Potential vehicle operations problems were observed on this section of roadway during the field review. From the Engineer's perspective during subjective evaluations at the site, it was noted that several additional factors could create potential problems at this site.

1. The curve sections are the only deviations from tangent on the entire route. The turns are sharp 90 degrees corners which requires a significant decrease in speed to negotiate. The curves

have a Ballbank reading of 12 degrees at 20 mph. While the paved tangent sections could reasonable carry traffic at an average speed in excess of 45 mph. Adequate attention is not given to this situation.

2. Sight distance at the curve is severely impeded by trees and other vegetation growing within the inside of the curve.

3. The speed limit signs are in the worst possible location since they would indicate that the curve is a 35 mph curve. This situation deliberately misleads the driver and should be of extreme cause for concern.

4. Although the roadway is paved, there are areas of extreme roughness which causes vehicle control problems.

5. The 35 mph speed zone seems unrealistic when the roadside environment, pavement surface and low traffic volumes are considered. A speed survey should be conducted to determine the proper speed limits.

Accidents. The collision diagram and accident statistics tables shown on the existing condition sketch indicates that there were nine accidents recorded in the four year study period. The accidents seem to be increasing, since there were six in 1988 alone. The type of accidents primarily involved single vehicle accidents with two head-on accidents in the middle of the sharp and narrow curves..

The majority of accidents occurred in fair weather conditions and on dry roads. Accidents occurred predominantly

during the night time hours. The severity of accidents at this site is high, with the majority being injury type accidents.

SHORT TERM IMPROVEMENTS

Suggested improvements at this site strive to reduce the effects of the above noted problems. Over-sized curve warning signs are considered necessary 500 feet in advance of the curves to provide adequate warning of the severe curvature conditions. Advisory speed plates are critical for these curves.

Proper delineation of the roadway path is especially critical at the curves. However, the curves are so sharp that the arrow panel sign is the only devices that could be reasonably applied. Pavement markings are extremely desirable at this site to provide visual information on the roadway alignment, assign proper lanes and delineate safe passing zones. Speed limit signs should be located past the curves for the desired direction of travel only. The existing speed limit signs should be relocated immediately or at least removed until the other improvements are made.

Removal of vegetation on the inside of corners and at key points along the roadway will provide the most important improvements by allowing drivers more time to anticipate and react.

The cost of these improvements is estimated to be approximately $6,505 based on 1989 unit bid contract prices and MDOH fund eligible prices. The pavement markings should be much

less if county crews performed the work and the striping were to be completed as part of a county wide pavement marking program.

Long term improvements at this site would involve reconstructing the curves to provide a design speed of at least 35 mph and sufficient widening for logging trucks to meet and pass within the curve. The long term improvement should be considered necessary when traffic volumes exceed 2,000 ADT.

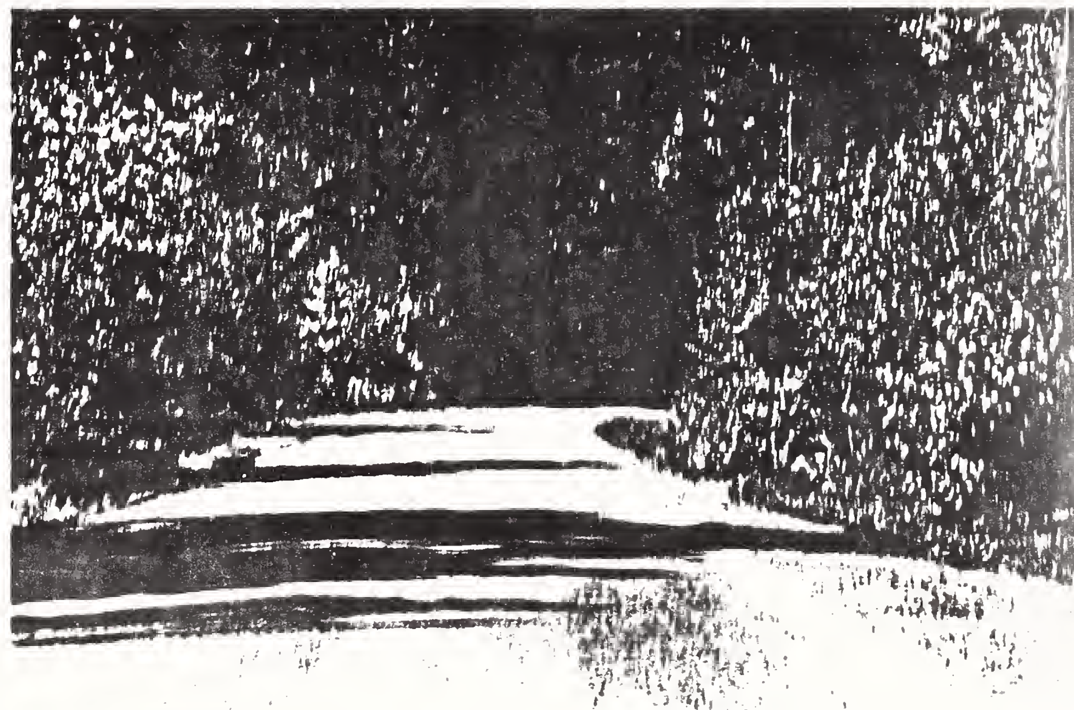
BENEFITS

The annual dollar benefit that may be realized from the short term improvements is computed to be approximately $14,258 annually. The benefit/cost ratio is computed to be 7.85 according to methods developed by the Montana Department of Highways.

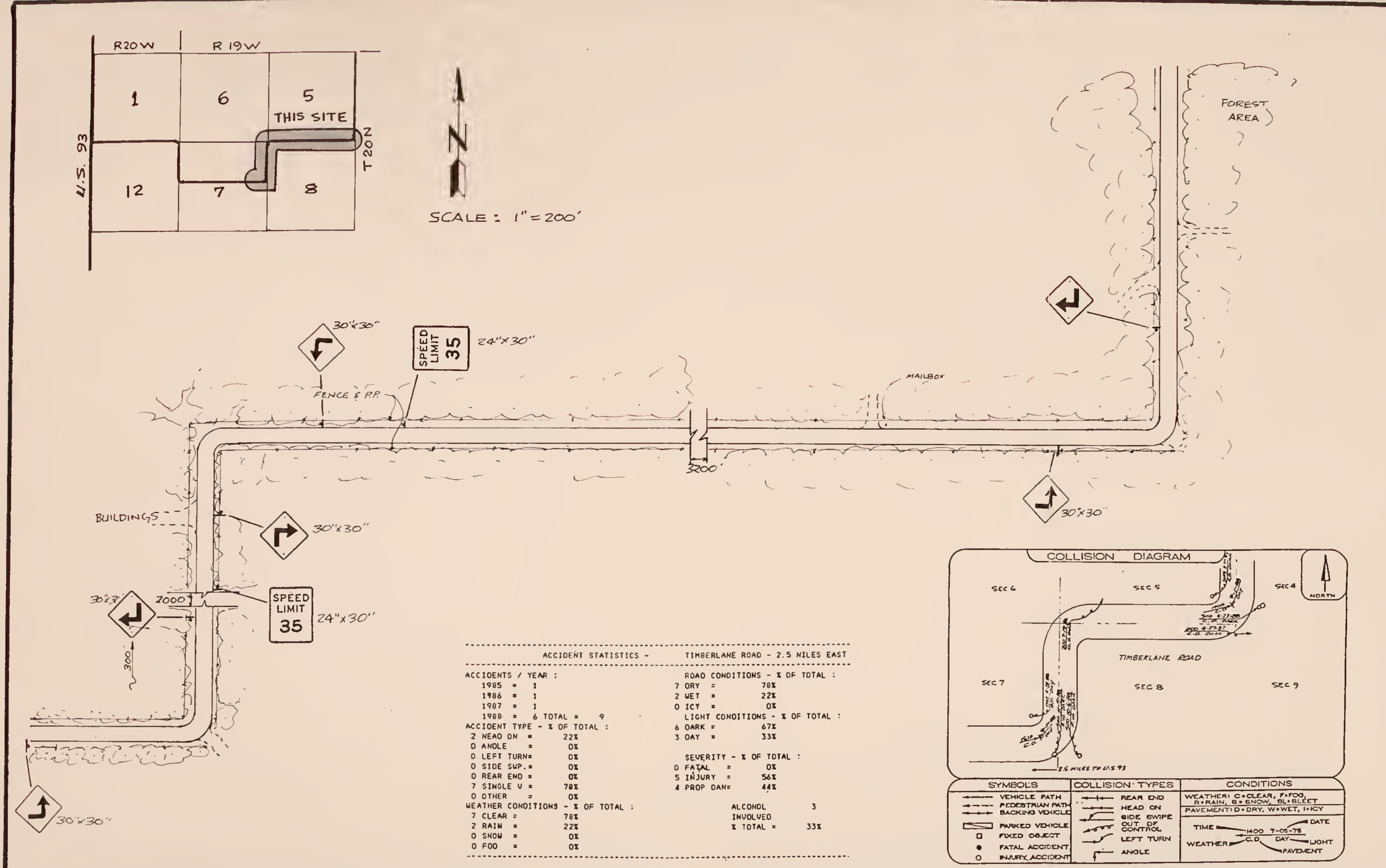
TIMBERLANE RD CURVE @ 2.5 MILE, EASTBOUND

TIMBERLANE RD CURVE @ 2.5 MILE, SOUTHBOUND

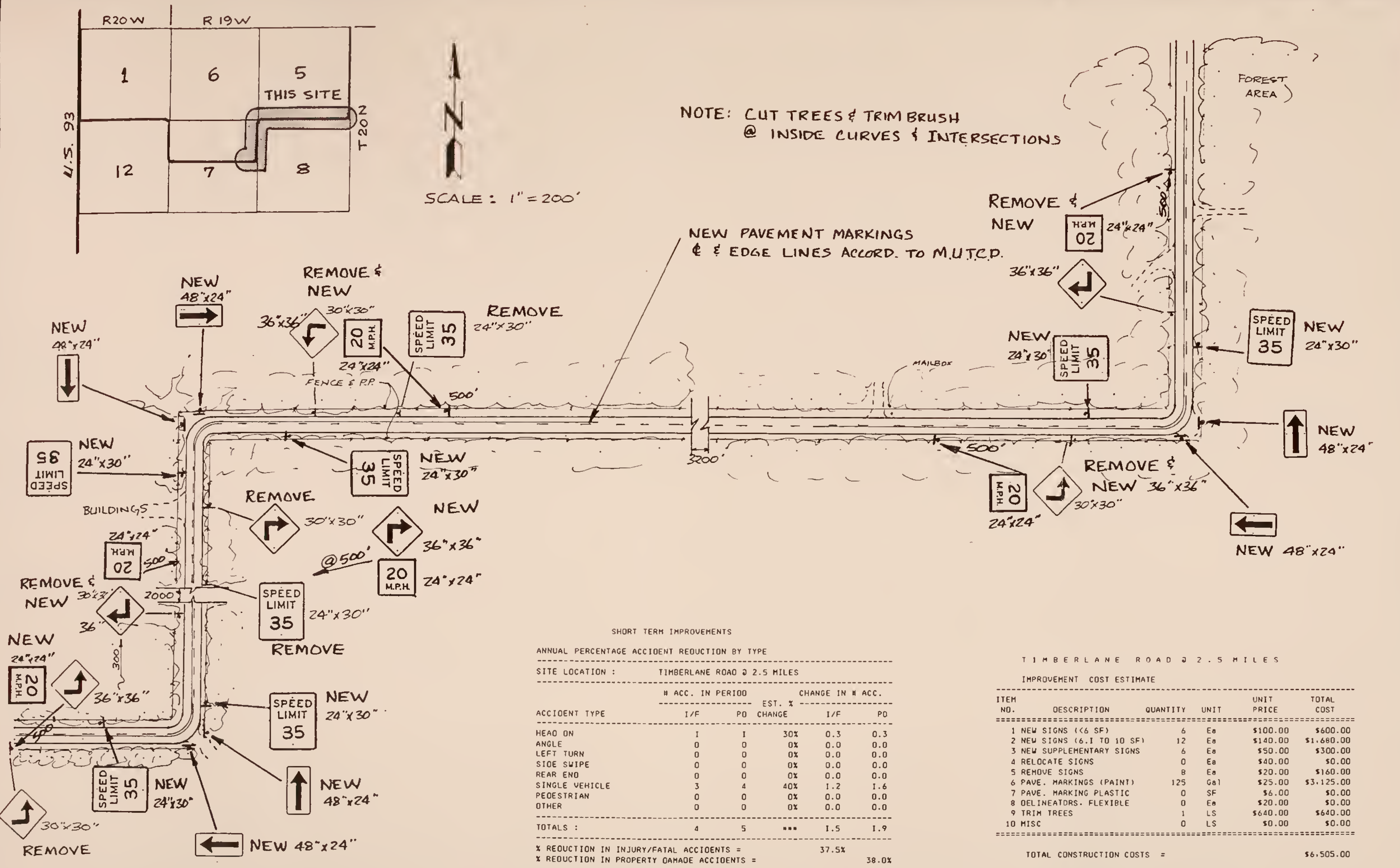
TIMBERLANE RD CURVE @ 3.0 MILE, WESTBOUND



TIMBERLANE RD CURVE @ 4.0 MILE, SOUTHBOUND



MARVIN & ASSOCIATES Traffic Transportation & Civil Engineers	SUITE 304 TRANSWESTERN I 404 N. 31st BILLINGS, MT 59107 Ph. (406) 248-5088	Project : LAKE COUNTY TRAFFIC SAFETY STUDY	Sheet Title : TIMBERLANE ROAD - 2.5 MILES EXISTING CONDITIONS	Surveyed By : Designed By : Drawn By : Checked By : Date :	Revisions No. ___ Date ___ No. ___ Date ___ No. ___ Date ___ No. ___ Date ___	Project No. Client No. Sheet No. 1 of ___



SHORT TERM IMPROVEMENTS

ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : TIMBERLANE ROAD @ 2.5 MILES

ACCIDENT TYPE	# ACC. IN PERIOD I/F	# ACC. IN PERIOD PD	EST. % CHANGE	CHANGE IN # ACC. I/F	CHANGE IN # ACC. PD
HEAD ON	1	1	30%	0.3	0.3
ANGLE	0	0	0%	0.0	0.0
LEFT TURN	0	0	0%	0.0	0.0
SIDE SWIPE	0	0	0%	0.0	0.0
REAR END	0	0	0%	0.0	0.0
SINGLE VEHICLE	3	4	40%	1.2	1.6
PEDESTRIAN	0	0	0%	0.0	0.0
OTHER	0	0	0%	0.0	0.0
TOTALS :	4	5	***	1.5	1.9

% REDUCTION IN INJURY/FATAL ACCIDENTS = 37.5%
% REDUCTION IN PROPERTY DAMAGE ACCIDENTS = 38.0%

T I M B E R L A N E R O A D @ 2 . 5 M I L E S

IMPROVEMENT COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	NEW SIGNS (<6 SF)	6	Ea	$100.00	$600.00
2	NEW SIGNS (6.1 TO 10 SF)	12	Ea	$140.00	$1,680.00
3	NEW SUPPLEMENTARY SIGNS	6	Ea	$50.00	$300.00
4	RELOCATE SIGNS	0	Ea	$40.00	$0.00
5	REMOVE SIGNS	8	Ea	$20.00	$160.00
6	PAVE. MARKINGS (PAINT)	125	Gal	$25.00	$3,125.00
7	PAVE. MARKING PLASTIC	0	SF	$6.00	$0.00
8	DELINEATORS, FLEXIBLE	0	Ea	$20.00	$0.00
9	TRIM TREES	1	LS	$640.00	$640.00
10	MISC	0	LS	$0.00	$0.00

TOTAL CONSTRUCTION COSTS = $6,505.00

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Project : LAKE COUNTY TRAFFIC SAFETY STUDY

Sheet Title : TIMBERLANE ROAD - 2.5 MILES SHORT TERM IMPROVEMENTS

Surveyed By :
Designed By :
Drawn By :
Checked By :
Date :

Revisions
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No. Date
No. Date

Project No.
Client No.

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TERRACE LAKE ROAD
PRIORITY NUMBER 5

SITE DESCRIPTION

Terrace Lake Road is a main east-west arterial road running across the width of Lake County. It begins 12 miles west of Ronan where it is known as Round Butte Road or FAS 211. It is designated as Terrace Lake Road east of Ronan, where it extends to a point approximately 4.0 miles east. It connects all north-south routes in the valley and provides access to farms, residences and newer subdivision developments along its course.

The accident cluster area extends from a point approximately 0.5 miles east of Highway 93 a distance of approximately two miles.

EXISTING CONDITIONS

Geometrics. The site geometrics are shown in the existing condition sketch. The roadway has 24 foot wide pavement surface with variable width shoulders, ditch sections and various roadside conditions. Numerous drive approaches and road approaches are located along the entire length of the site. Vertical grades range between flat and 7% with numerous vertical curves. The pavement surface is in adequate condition, overall, with some rough spots at intermittent points within the site area.

Traffic Control Devices. The most prevalent traffic control devices are speed limit signs. There are also stop signs located on some of the higher volume approach roads. One advance intersection warning sign exists. This sign is in advance of a of an approach road to a new residential subdivision. There are no pavement markings existing at this site.

Traffic Volumes. The current traffic volume on this section of roadway is approximately 1,500 vehicles per day. Traffic volumes throughout the past four years have probably increased by approximately 4% or more. The County could not provide historical counts at this site. However, the Department of Highways was able to provide several years of traffic counts on FAS 211 just west of Highway 93 which could be statistically coordinated with this site. The directional split on this roadway is approximately 40%-60% which means that at certain periods of the day, 40% of the vehicles are going in one direction while the remainder are headed in the other.

Traffic Operations. Some conflicts in vehicle operations were observed on this section of roadway during the field review. From the Engineer's perspective during subjective evaluations at the site, it was noted that several factors could also create potential problems at this site.

1. There is a momentary loss of passing sight distance and intersection sight distance in both travel directions because of crest vertical curves at three separate locations.

2. Approaches and road intersections are somewhat hidden by vegetation growing alongside the roadway.

3. Lack of any delineation or positive guidance is most noticeable in this higher traffic volume area.

4. The speed limit seems to be inappropriate for the type of road and roadside environment on the east half of the site.

Accidents. The collision diagram and accident statistics tables shown on the existing condition sketch indicates that there were seventeen accidents recorded in the four year study period. The accident rate seems to be consistent over the period, with nearly equal numbers of accidents occurring in each of the years. The majority of accidents were single vehicle accidents, mostly away from the intersection areas. Rear-end, angle, side-swipe and left turn accidents occurred at the intersection areas.

The majority of accidents occurred in fair weather conditions and on wet or icy roads. Accidents occurred with almost equal frequency during daylight and night time hours. The severity of accidents at this site is not high with only 29% of them producing injuries.

SHORT TERM IMPROVEMENTS

Suggested improvements at this site strive to reduce the effects of some of the above noted problems. The sight distance restrictions should be removed as best as practical at the intersections. Trees could be removed if agreements are made with

the landowner. Intersection warning signs with supplementary street name plates will reduce some accidents at the intersections. It has been found that the supplementary name plates on the advanced warning sign not only helps drivers locate their approach road but it provides adequate time for them to plan a turn safely. Pavement markings will provide the biggest improvement at this location. The markings will not only delineate lane assignments, but it will provide information on passing restrictions at intersections and on blind vertical curves.

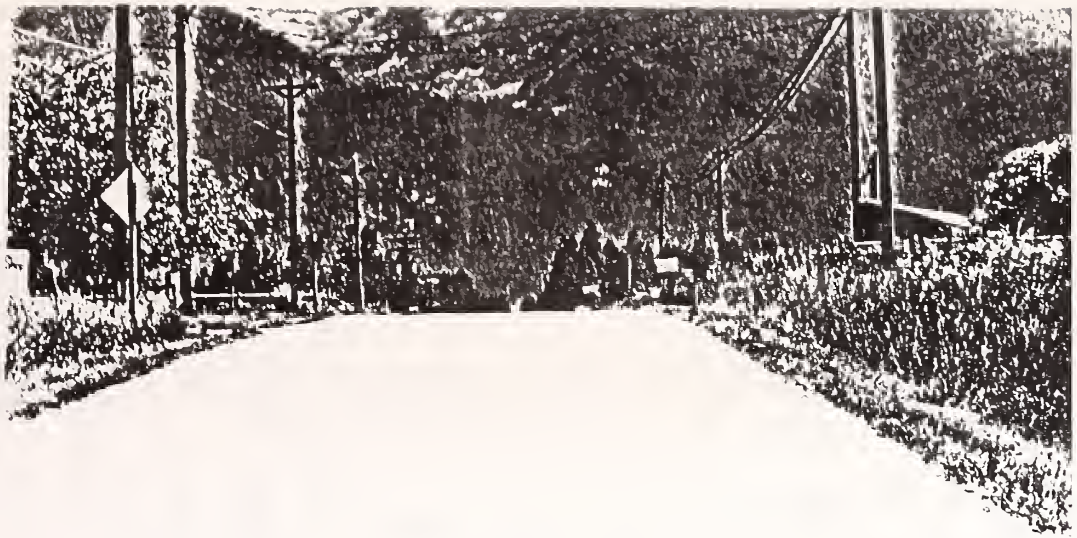
The cost of these improvements is estimated to be approximately $4,820 based on 1989 unit bid contract prices and MDOH fund eligible prices. The pavement markings should be much less if county crews performed the work or the striping were to be completed as part of a county wide pavement marking program.

Long term improvements at this site should be consider upgrading the entire roadway to urban type standards as future growth occurs. It would be advisable to begin planning these improvements now so that sections of the roadway could be improved as the future demands require.

BENEFITS

The annual dollar benefit that may be realized from the short term improvements is computed to be approximately $10,204 annually.

The percentage reduction in accidents at this site is lowest of all the sites. However, the benefit/cost ratio is still computed according to be 7.44, by accepted methods.

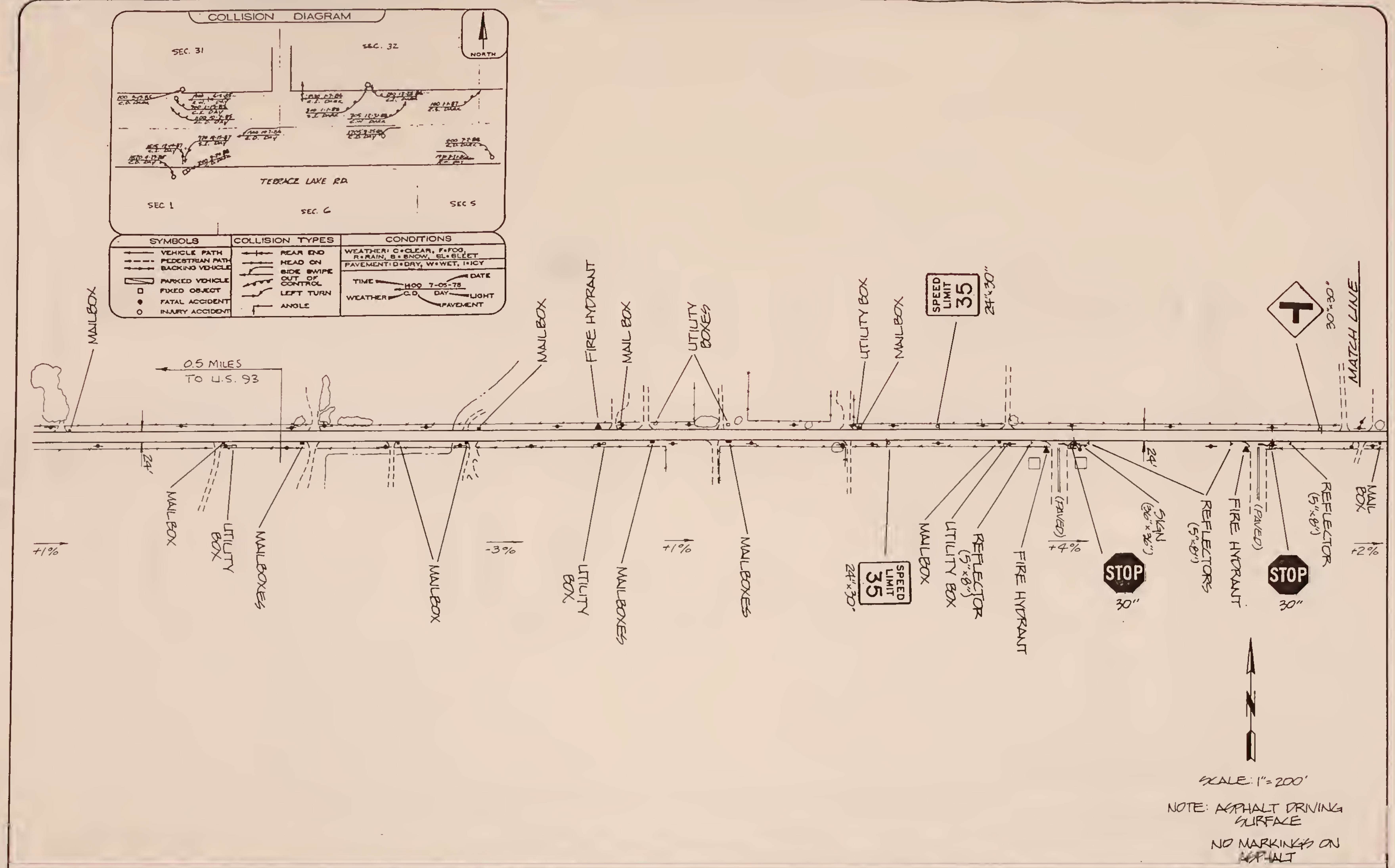


TERRACE LAKE DR @ NEW SUB ACCESS, EASTBOUND

TERRACE LAKE DR W OF FOOTHILLS DR, EASTBOUND

TERRACE LAKE DR @ 2 MILES, WESTBOUND

TERRACE LAKE DR @ FOOTHILLS DR, WESTBOUND



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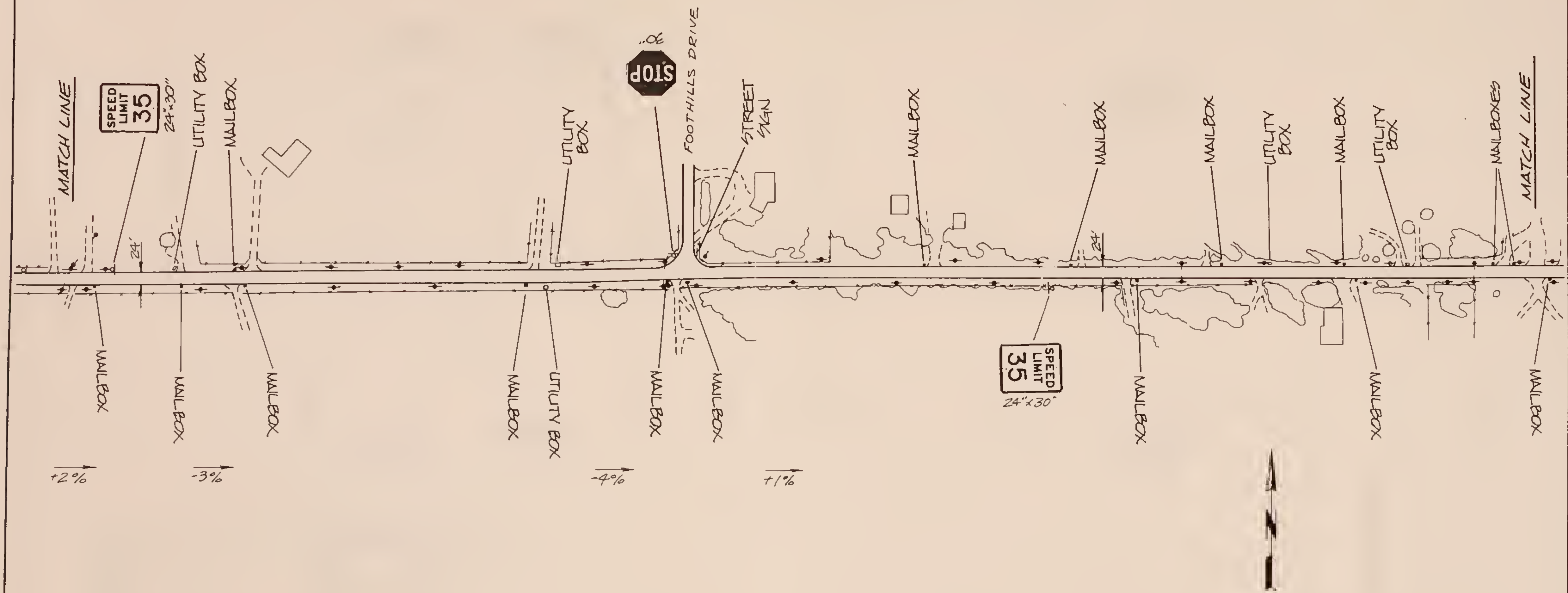

SCALE: 1"=200'

NOTE: ASPHALT DRIVING SURFACE

NO MARKINGS ON ASPHALT

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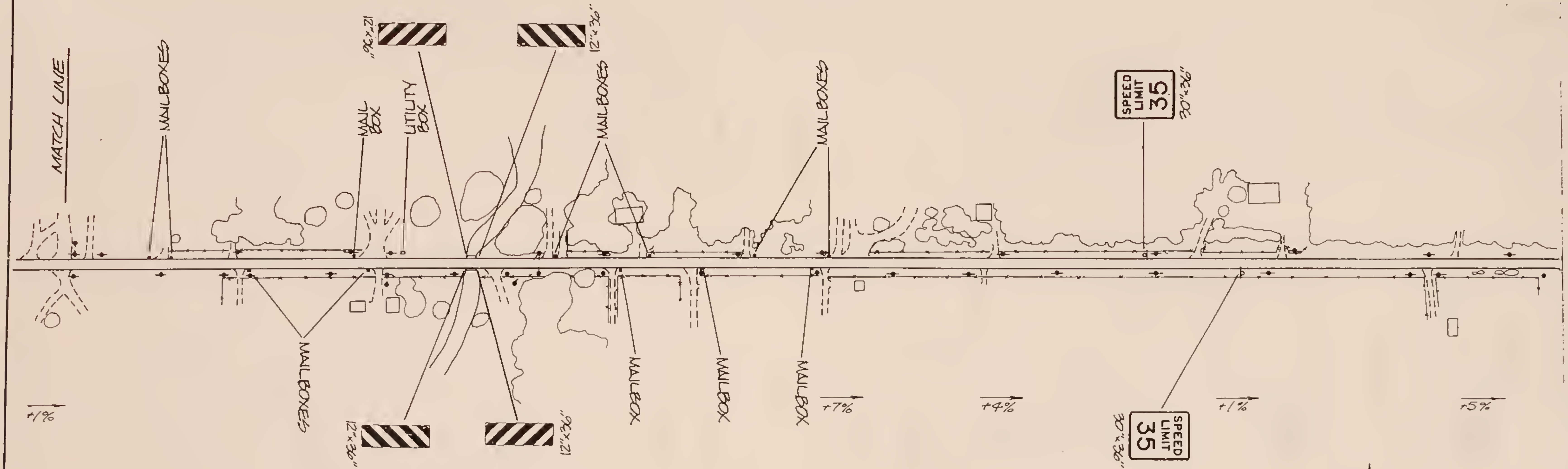


ACCIDENT STATISTICS - TERRACE LAKE ROAD

ACCIDENTS / YEAR :

1985	=	5
1986	=	4
1987	=	3
1988	=	5 TOTAL = 17

ACCIDENT TYPE - % OF TOTAL :

0	HEAD ON =	0%
2	ANGLE =	12%
1	LEFT TURN=	6%
2	SIDE SWP.=	12%
1	REAR END =	6%
11	SINGLE V =	65%
0	OTHER =	0%

WEATHER CONDITIONS - % OF TOTAL :

13	CLEAR =	76%
2	RAIN =	12%
2	SNOW =	12%
0	FOG =	0%

ROAD CONDITIONS - % OF TOTAL :

7	DRY =	41%
3	WET =	18%
7	ICY =	41%

LIGHT CONDITIONS - % OF TOTAL :

8	DARK =	47%
9	DAY =	53%

SEVERITY - % OF TOTAL :

0	FATAL =	0%
5	INJURY =	29%
12	PROP DAM=	71%

ALCOHOL INVOLVED 5
% TOTAL = 29%

SCALE: 1"=200'

NOTE: ASPHALT DRIVING SURFACE

NO MARKINGS ON ASPHALT

MARVIN & ASSOCIATES
Traffic Transportation & Civil Engineers
SUITE 304 TRANSWESTERN I
404 N. 31st
BILLINGS, MT 59107
Ph. (406) 248-5088

Project :
LAKE COUNTY
TRAFFIC SAFETY STUDY

Sheet Title :
TERRACE LAKE ROAD
EXISTING CONDITIONS

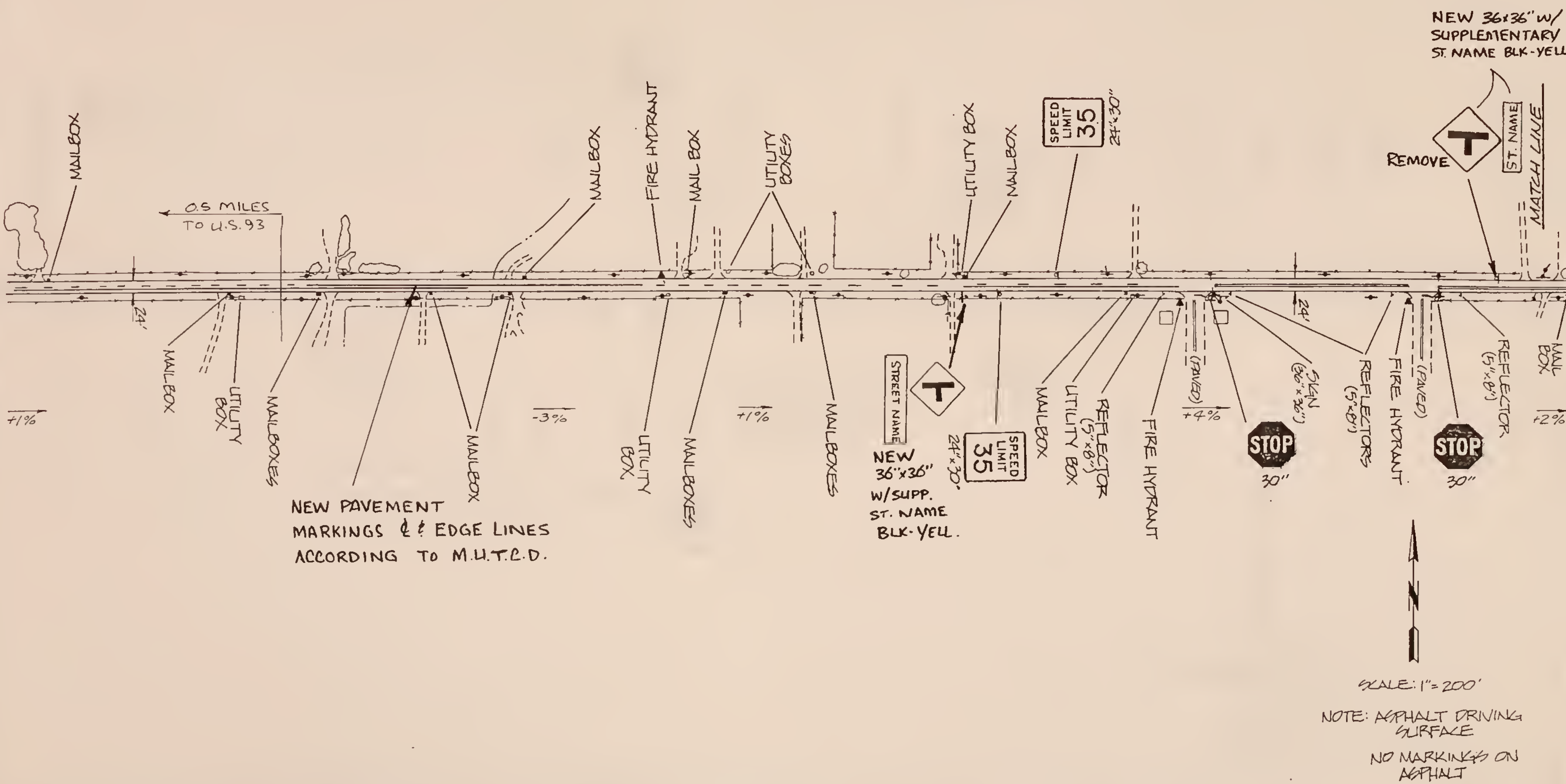
Surveyed By :
Designed By :
Drawn By
Checked By :
Date

Revisions
No. ____ Date ____
No. ____ Date ____
No. ____ Date ____
No. ____ Date ____

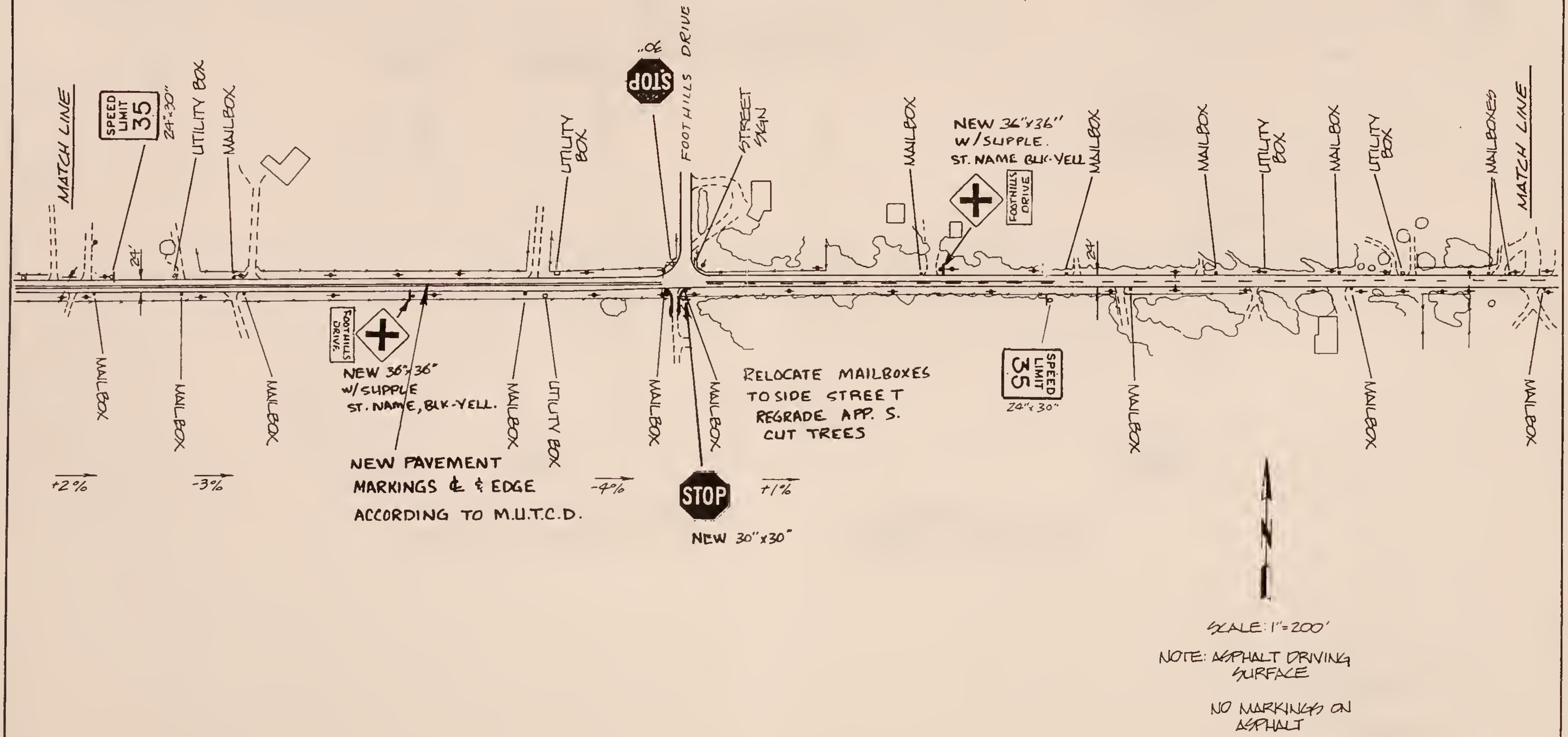
Project No.
Client No.

Sheet No.
3
of

NOTE: REMOVE OR CUT ALL VEGETATION IN R/W - ENTIRE LENGTH



MARVIN & ASSOCIATES Traffic Transportation & Civil Engineers SUITE 304 TRANSWESTERN I 404 N. 31st BILLINGS, MT 59101 Ph. (406) 245-5088	Project: LAKE COUNTY TRAFFIC SAFETY STUDY	Sheet Title: TERRACE LAKE ROAD SHORT TERM IMPROVEMENTS	Sheet No. 1 of



MARVIN & ASSOCIATES Traffic Transportation & Civil Engineers SUITE 304 TRANSWESTERN I 404 N. 31st BILLINGS, MT 59107 Ph (406) 248-5088	Project: LAKE COUNTY TRAFFIC SAFETY STUDY	Sheet Title: TERRACE LAKE ROAD SHORT TERM IMPROVEMENTS	Surveyed By: Designed By: Drawn By: Checked By: Date:	Revisions No. Date No. Date No. Date No. Date	Project No. Client No.	Sheet No. 2

SHORT TERM IMPROVEMENTS

ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : TERRACE LAKE ROAD

ACCIDENT TYPE	# ACC. IN PERIOD I/F	# ACC. IN PERIOD PD	EST. % CHANGE	CHANGE IN # ACC. I/F	CHANGE IN # ACC. PD
HEAD ON	0	0	0%	0.0	0.0
ANGLE	0	2	20%	0.0	0.4
LEFT TURN	0	1	20%	0.0	0.2
SIDE SWIPE	0	2	30%	0.0	0.6
REAR END	0	1	40%	0.0	0.4
SINGLE VEHICLE	5	6	20%	1.0	1.2
PEDESTRIAN	0	0	0%	0.0	0.0
OTHER	0	0	0%	0.0	0.0
TOTALS :	5	12	***	1.0	2.8

% REDUCTION IN INJURY/FATAL ACCIDENTS = 20.0%

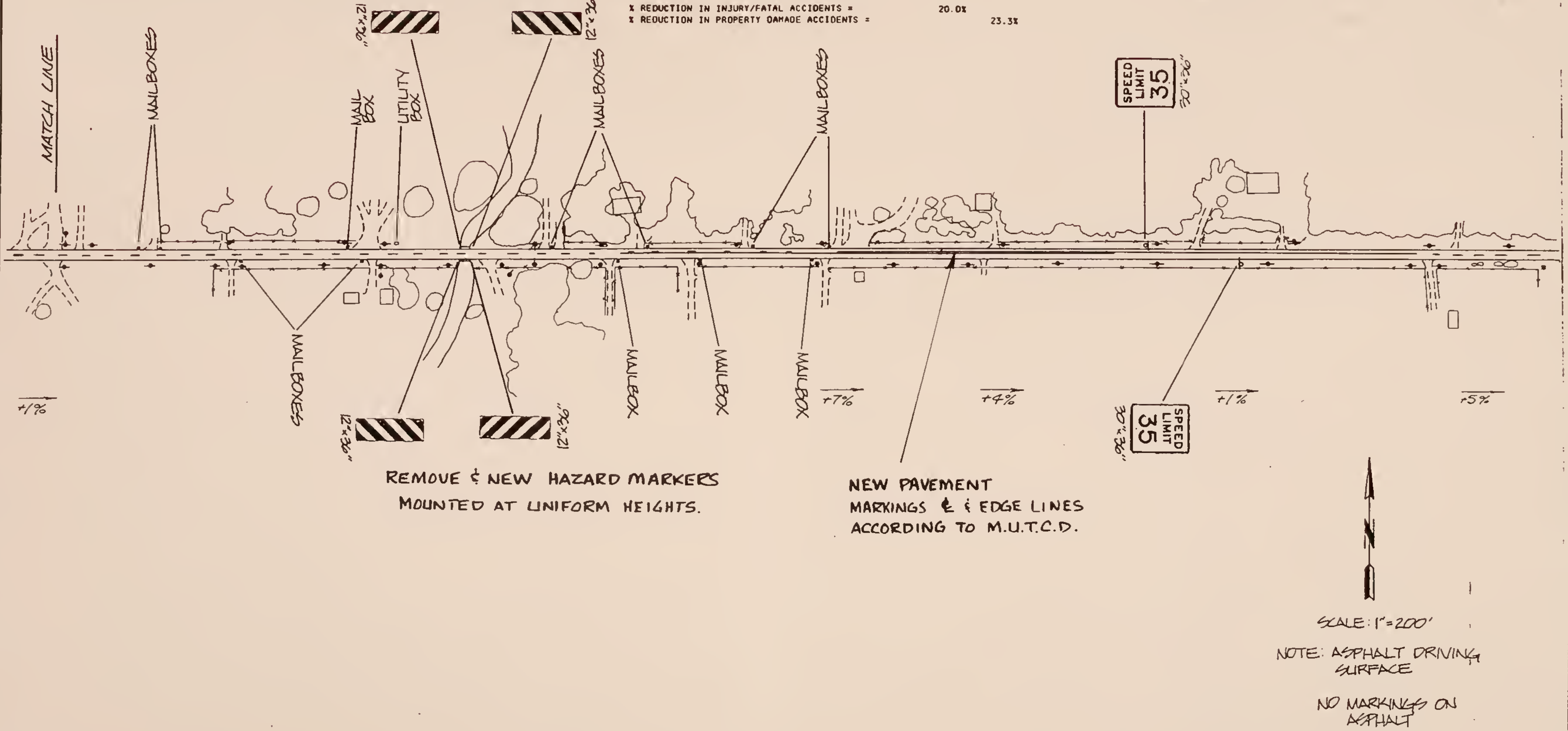
% REDUCTION IN PROPERTY DAMAGE ACCIDENTS = 23.3%

TERRACE LAKE ROAD

IMPROVEMENT COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	NEW SIGNS (<6 SF)	5	Ea	$100.00	$500.00
2	NEW SIGNS (6.1 TO 10 SF)	4	Ea	$140.00	$560.00
3	NEW SUPPLEMENTARY SIGNS	4	Ea	$50.00	$200.00
4	RELOCATE SIGNS	0	Ea	$40.00	$0.00
5	REMOVE SIGNS	5	Ea	$20.00	$100.00
6	PAVE. MARKINGS (PAINT)	100	Gal	$25.00	$2,500.00
7	PAVE. MARKING PLASTIC	0	SF	$6.00	$0.00
8	DELINEATORS, FLEXIBLE	0	Ea	$20.00	$0.00
9	TRIM TREES	1	LS	$960.00	$960.00
10	MISC	0	LS	$0.00	$0.00

TOTAL CONSTRUCTION COSTS = $4,820.00



MARVIN & ASSOCIATES Traffic Transportation & Civil Engineers	SUITE 304 TRANSWESTERN I 404 N. 31st BILLINGS, MT 59107 Ph. (406) 248-5088	Project: LAKE COUNTY TRAFFIC SAFETY STUDY	Sheet Title: TERRACE LAKE ROAD SHORT TERM IMPROVEMENTS	Surveyed By: Designed By: Drawn By: Checked By: Date:	Revisions No. Date No. Date No. Date No. Date	Project No. Client No.	Sheet No. 3 of

SITE #6

ROUND BUTTE ROAD
PRIORITY NUMBER 6

SITE DESCRIPTION

Round Butte Road is an east-west rural arterial type road which extends across Lake County. It is also known as FAS 211 or Terrace Lake Road on the east side of Ronan. It is part of the state secondary system. It extends from a point 12 miles west of Ronan to a point 4 miles east of Ronan. It provides access to farms, rural residences and other land uses along its length.

This site is located ten miles west of Ronan at an intersection with Hot Springs Road, just west of Sloan Road.

EXISTING CONDITIONS

Geometrics. The site geometrics are shown in the existing condition sketch. Accident cluster areas are located at the intersection with Hot Springs Road, which is a "T" intersection. The roadway has a 24 foot wide pavement surface and was constructed to old secondary highway standards. Vertical grades at this site are between 1 and 2%. The roadside environment is primarily rolling farm land with no large trees in the immediate area. The ditch slopes are relatively flat and wide.

The intersection area is paved on the east and south legs. The extended tangent sections of road approaches deviates with a slight curve to the north at the intersection. This curve was apparently constructed to accommodate a larger turn radius for the

left turn movement from westbound to southbound. A slight superelevation was constructed in this curve, which creates a sharp grade break and transition from pavement to gravel for east-west through traffic.

Traffic Control Devices. There are four types of signs existing at this site. An intersection warning sign is in place for westbound traffic, but it is only 200 feet in advance of the intersection. A combination street name and guide sign is within 100 feet of the intersection for westbound traffic. A stop sign is installed for Sloan Road traffic and a load limit sign is located for eastbound traffic. Pavement marking seem to be correctly applied at this location.

Traffic Volumes. The current traffic volume on this section of roadway is approximately 220 vehicles per day. Traffic volumes throughout the past four years have probably remained fairly constant. The County could not provide historical counts at this site. However, the Montana Department of Highways provided several years of counts at this location. The predominant traffic movement at this intersection is westbound to southbound. The directional split on this roadway is approximately 40%-60% which means that at certain periods of the day, 40% of the vehicles are going in one direction while the remainder are headed in the other.

Traffic Operations. Potentially serious vehicle operations problems were observed on this section of roadway during the field review. From the Engineer's perspective during subjective evaluations at the site, it was noted that several additional factors could create potential problems at this site.

1. This site is located at the end of a tangent section that extends for ten miles. Traffic speeds are 55 mph or greater on what appears to be an open highway. Two critical changes occur at the site. The pavement ends at the same place where the major side road intersects. Neither condition is readily apparent on the westbound approach to this site. Westbound traffic, whether turning or going straight, are subject to unexpected conditions.

2. The pavement appears to make a turn to the right on the advanced approach for westbound traffic when actually the pavement makes a sharp turn to the left. This visual clue is the most deceiving of all conditions encountered at this site.

3. The superelevation of the pavement cause a sharp grade break in the through lanes. The grade break is so extreme that a vehicle could easily become airborne at speeds in excess of 55 mph. To make matters worse, westbound traffic encounter a loose gravel landing on the other side of the intersection.

4. Gravel from Hot Springs Road and the west side of Round Butte Road is kicked onto the paved surface at a point that maximum road friction is required for vehicle maneuvers.

5. The only section of pavement along Round Butte Road that have black spots on the surface, is in the westbound approach lane to this intersection. These spots occur from braking action on the pavement and are composed of both rubber and bleeding asphalt. This indicates the frequent use of extreme braking maneuvers.

Accidents. The collision diagram and accident statistics tables shown on the existing condition sketch indicates that there were two accidents recorded in the four year study period. One in 1986 and one in 1988. Both accidents were single vehicle accidents involving loss of control at the intersection area. With only two accidents, this site still had the second highest accident rate of all the study sites.

Both accidents occurred on dry roads in clear weather. One of the accidents occurred at night while the other was in day light conditions. Accident severity is high with one fatality and one injury type accident.

SHORT TERM IMPROVEMENTS

Suggested improvements at this site strive to reduce the effects of the above noted problems. Over-sized intersection warning signs with supplementary street name plates are considered necessary due to the level of expectancy at this intersection. The advanced street name plates will assist drivers in locating the turn and in planning a safe turning maneuver.

It is imperative that the road surface be improved to eliminate the sharp vertical break; to keep loose gravel out of the intersection area; and to extend the pavement end beyond the intersection where conditions already occupies the driver's concentration. Advanced pavement ends signing can thus be installed at a location where a motorist can perceive its meaning and actually see the conditions to be encountered.

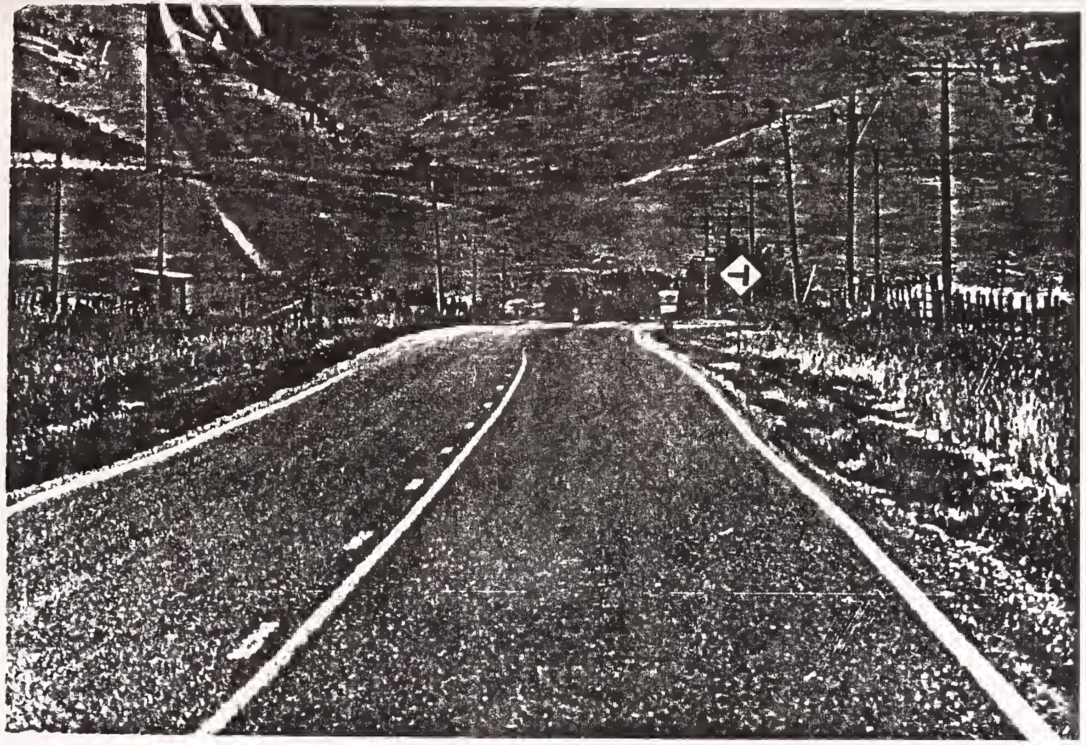
Right of way control at this intersection must be signed to avoid conflicts even though they may be rare. A yield sign on Hot Springs Road will provide adequate control for the volumes and geometry of the reconstructed intersection.

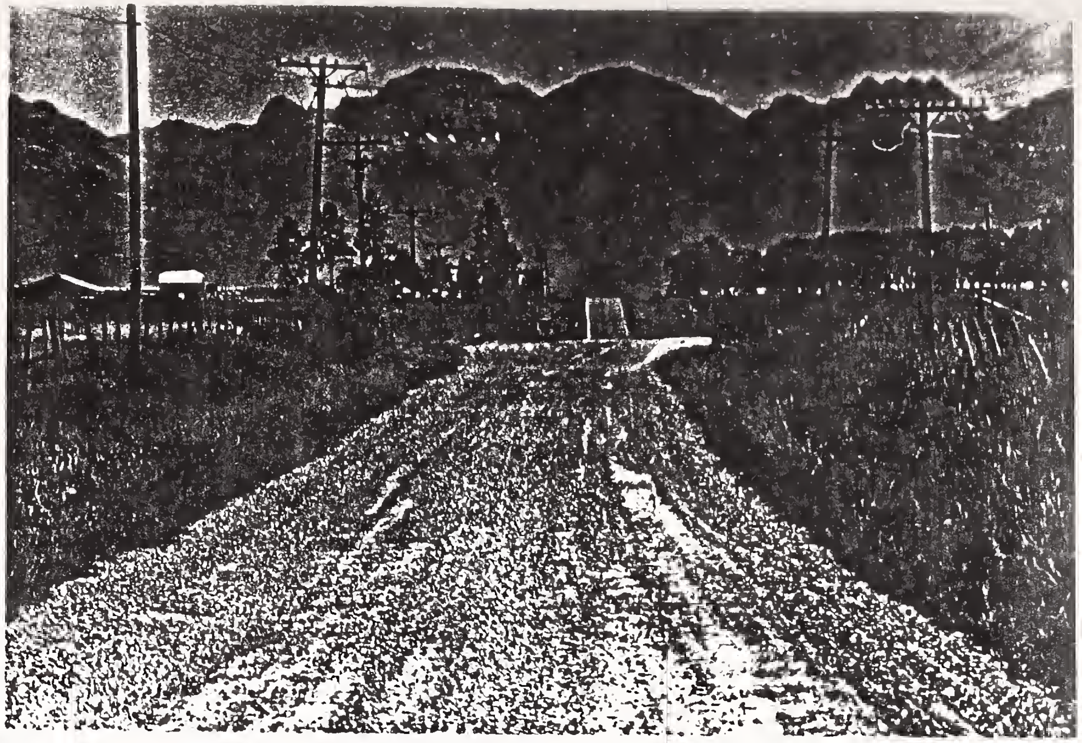
The cost of these improvements is estimated to be approximately $8,830 based on 1989 unit bid contract prices and MDOH fund eligible prices. The reconstruction and pavement markings should be much less if county crews performed the work and the striping were to be completed as part of a county wide pavement marking program.

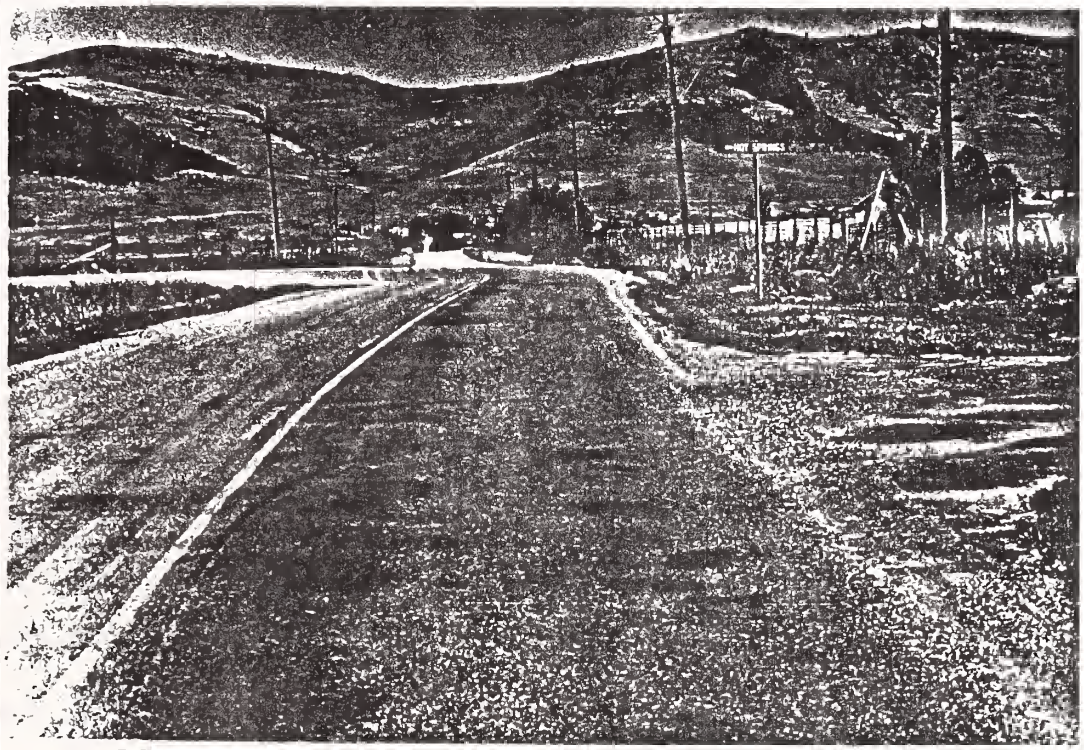
Long term improvements at this site cannot be foreseen until traffic volumes increase beyond 2,000 ADT. If similar traffic patterns exist in the future, the westbound to southbound travel path should be built on a large radius curve and the west side of Round Butte Road relocated to the middle of the curve in a button hook fashion.

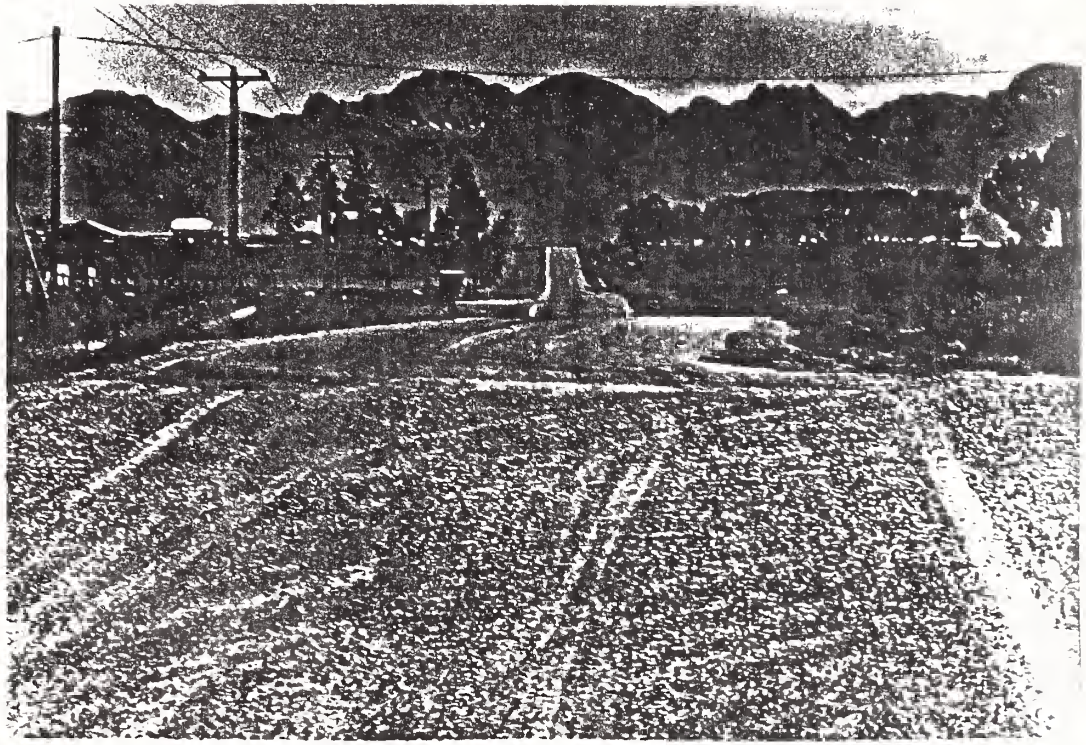
BENEFITS

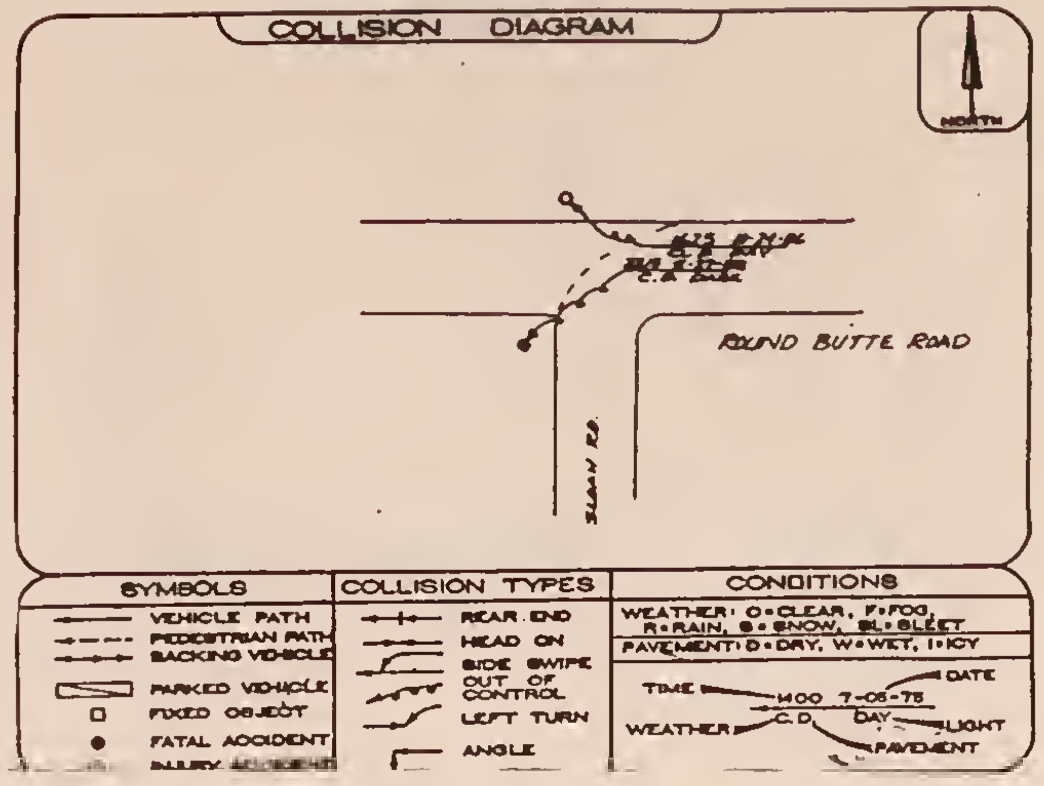
The annual dollar benefit that may be realized from the short term improvements is computed to be approximately $8,224 annually. The benefit/cost ratio is computed to be 3.46 according to methods developed by the Montana Department of Highways. Even with reconstruction costs, this is an economically attractive improvement project.


ROUND BUTTE RD, WESTBOUND


ROUND BUTTE RD, EASTBOUND


ROUND BUTTE RD @ INTERSECTION, WESTBOUND


ROUND BUTTE RD @ INTERSECTION, EASTBOUND



ACCIDENT STATISTICS - ROUND BUTTE ROAD - SLOAN ROAD

ACCIDENTS / YEAR :
1985 = 0
1986 = 1
1987 = 0
1988 = 1 TOTAL = 2

ACCIDENT TYPE — % OF TOTAL :
0 HEAD ON = 0%
0 ANGLE = 0%
0 LEFT TURN = 0%
0 SIDE SWP. = 0%
0 REAR END = 0%
2 SINGLE V = 100%
0 OTHER = 0%

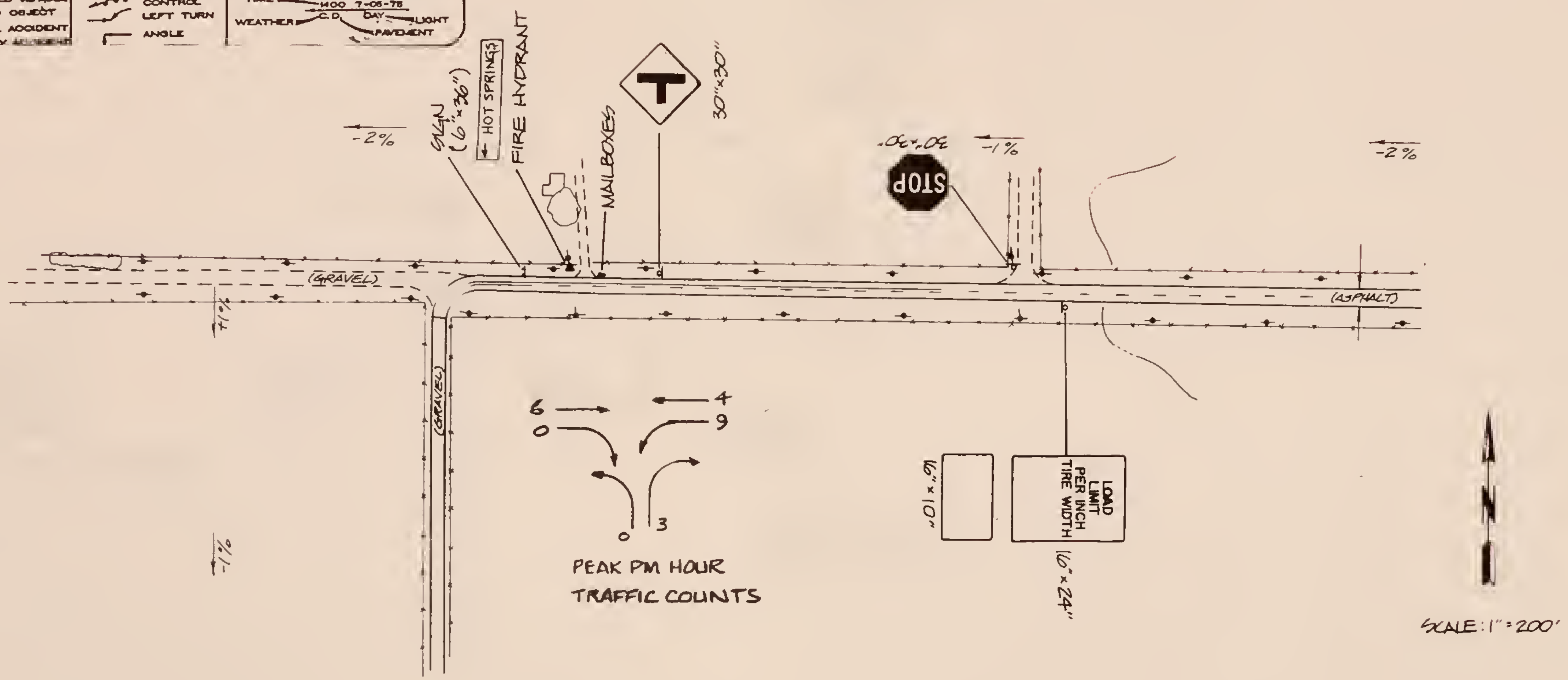
WEATHER CONDITIONS - % OF TOTAL :
2 CLEAR = 100%
0 RAIN = 0%
0 SNOW = 0%
0 FOG = 0%

ROAD CONDITIONS - % OF TOTAL :
2 DRY = 100%
0 WET = 0%
0 ICY = 0%

LIGHT CONDITIONS - % OF TOTAL :
1 DARK = 50%
1 DAY = 50%

SEVERITY - % OF TOTAL :
1 FATAL = 50%
1 INJURY = 50%
0 PROP DAM = 0%

ALCOHOL INVOLVED 0
% TOTAL = 0%



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BILLINGS MT 59107
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Project: LAKE COUNTY TRAFFIC SAFETY STUDY

Sheet Title: ROUND BUTTE ROAD EXISTING CONDITIONS

Surveyed By:
Designed By:
Drawn By:
Checked By:
Date:

Revisions
No. Date
No. Date
No. Date
No. Date

Project No.
Client No.

Sheet No. 1 of

SHORT TERM IMPROVEMENTS

ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : ROUND BUTTE ROAD

ACCIDENT TYPE	# ACC. IN PERIOD I/F	# ACC. IN PERIOD PD	EST. % CHANGE	CHANGE IN # ACC. I/F	CHANGE IN # ACC. PD
HEAD ON	0	0	0%	0.0	0.0
ANGLE	0	0	0%	0.0	0.0
LEFT TURN	0	0	0%	0.0	0.0
SIDE SWIPE	0	0	0%	0.0	0.0
REAR END	0	0	0%	0.0	0.0
SINGLE VEHICLE	2	0	45%	0.9	0.0
PEDESTRIAN	0	0	0%	0.0	0.0
OTHER	0	0	0%	0.0	0.0
TOTALS :	2	0	***	0.9	0.0

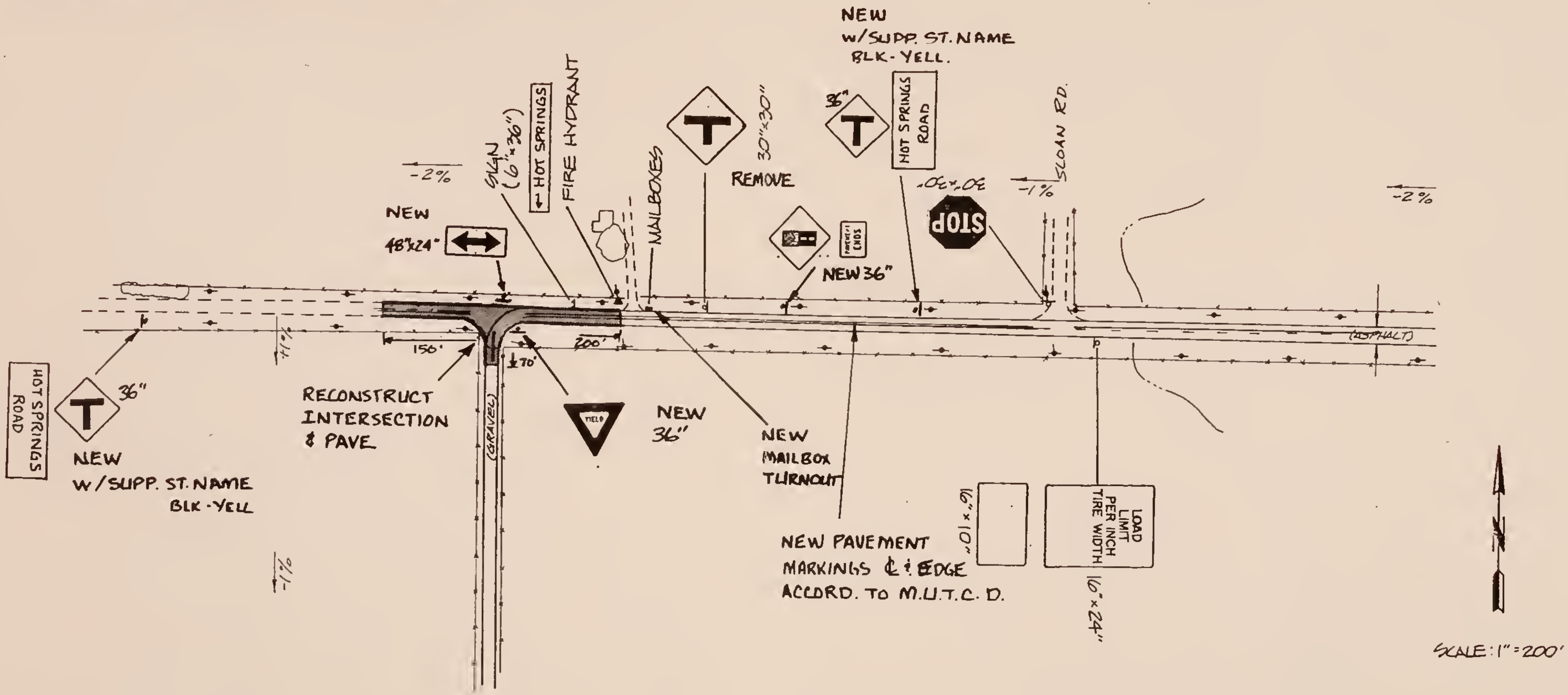
% REDUCTION IN INJURY/FATAL ACCIDENTS = 45.0%
% REDUCTION IN PROPERTY DAMAGE ACCIDENTS = ERR

ROUND BUTTE ROAD

IMPROVEMENT COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	NEW SIGNS (<6 SF)	1	Ea	$100.00	$100.00
2	NEW SIGNS (6.1 TO 10 SF)	4	Ea	$140.00	$560.00
3	NEW SUPPLEMENTARY SIGNS	3	Ea	$50.00	$150.00
4	RELOCATE SIGNS	0	Ea	$20.00	$0.00
5	REMOVE SIGNS	1	Ea	$20.00	$20.00
6	PAVE. MARKINGS (PAINT)	20	Gal	$25.00	$500.00
7	PAVE. MARKING PLASTIC	0	SF	$6.00	$0.00
8	DELINEATORS, FLEXIBLE	0	Ea	$20.00	$0.00
9	TRIM TREES	0	LS	$0.00	$0.00
10	GRADING & PAVING & MISC	1	LS	$7,500.00	$7,500.00

TOTAL CONSTRUCTION COSTS = $8,830.00



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Project: LAKE COUNTY TRAFFIC SAFETY STUDY

Sheet Title: ROUND BUTTE ROAD SHORT TERM IMPROVEMENTS

Surveyed By: ____
Designed By: ____
Drawn By: ____
Checked By: ____
Date: ____

Revisions
No. ___ Date ___
No. ___ Date ___
No. ___ Date ___
No. ___ Date ___

Project No.

Client No.

Sheet No. 1 of ___

SITE #7

TURTLE LAKE ROAD
PRIORITY NUMBER 7

SITE DESCRIPTION

Turtle Lake Road is an north-south rural type road which provides access to farms and residential subdivisions along its length. It begins at an intersection with State Highway 35 , about three miles east of Polson and continues south along the section line to an intersection with a east-west road approximately four miles south.

This site is located between a point approximately 0.3 miles south of Highway 35 and and intersection with Dupuis Road, a distance of 0.8 miles.

EXISTING CONDITIONS

Geometrics. Accident cluster areas are located at the intersection with Dupuis Road, which is a "T" intersection and along the tangent roadway north of the intersection, as shown on the sketch. The roadway has a 20 foot wide pavement surface. Shoulders and ditch sections along the road are undefinable. Fence lines and power poles crowd the roadway along its length. Vertical grades at this site are from 0% and 14%. The 14 % grade, in the middle of this site as well as other areas, have a rough pavement surface. The pavement ends just south of the intersection with Dupuis Road. At the top of the grade, near the Dupuis intersection, the roadside environment becomes densely forested.

Traffic Control Devices. There are two types of signs existing at this site. An arrow panel is in place at the end of Dupuis Road. A speed limit sign for northbound traffic exists and a yield sign is located on Dupuis Road. No pavement markings exist at this site.

Traffic Volumes. The current traffic volume on this section of roadway is approximately 800 vehicles per day. Traffic volumes throughout the past four years have probably increased by about 4%. The County could not provide historical counts at this site. The directional split on this roadway is approximately 40%-60% which means that at certain periods of the day, 40% of the vehicles are going in one direction while the remainder are headed in the other.

Traffic Operations. Potentially serious vehicle operations problems were observed on this section of roadway during the field review. From the Engineer's perspective during subjective evaluations at the site, it was noted that several additional factors could create potential problems at this site.

1. The extreme grade in the middle of this site combined with the rough road surface makes it extremely difficult for a driver to have complete control of the vehicle. Wet or icy road conditions would make an accident highly probable.

2. The vertical curve at the top of the 14% grade does not provide adequate stopping sight distance.

3. Trees in the northwest corner of the Dupuis intersection effectively block intersection sight distance.

4. The pavement ends right at the intersection where the greatest road friction requirements are needed.

5. The intersection location is not apparent to approaching traffic.

Accidents. The collision diagram and accident statistics tables shown on the existing condition sketch indicates that there were eleven accidents recorded in the four year study period. The most accidents in a year was in 1985 with six accidents. The trend would appear to be decreasing. Eight of the accidents were single vehicle accidents involving loss of control on the hill and on approaches to it. Three accidents were angle accidents at the Dupuis intersection.

Most of the accidents occurred on icy roads and in clear weather. The majority were during night time driving conditions. Severity of accidents at this site was quite low with only 18% of the accident resulting in injuries.

SHORT TERM IMPROVEMENTS

Suggested improvements at this site strive to reduce the effects of the above noted problems. Intersection warning signs with supplementary street name plates are considered necessary to properly define the intersection location to approaching traffic. The advanced street name plates will assist drivers in locating

the turn and in planning a safe turning maneuver.

It is imperative that the road surface be maintained especially during inclement weather. Closure on the hill should be considered during extreme conditions.

Limited sight distance signs should be installed so that drivers are aware of the sharp vertical alignment at the top of the hill and they can adjust their vehicle operation appropriately. Sight distance obstructions should be removed from the intersection area. Trees will need to be cut and land owners contacted to relocate any temporary structures. A stop sign would be more appropriate than a yield sign at the intersection because of sight distance problems and traffic volume levels.

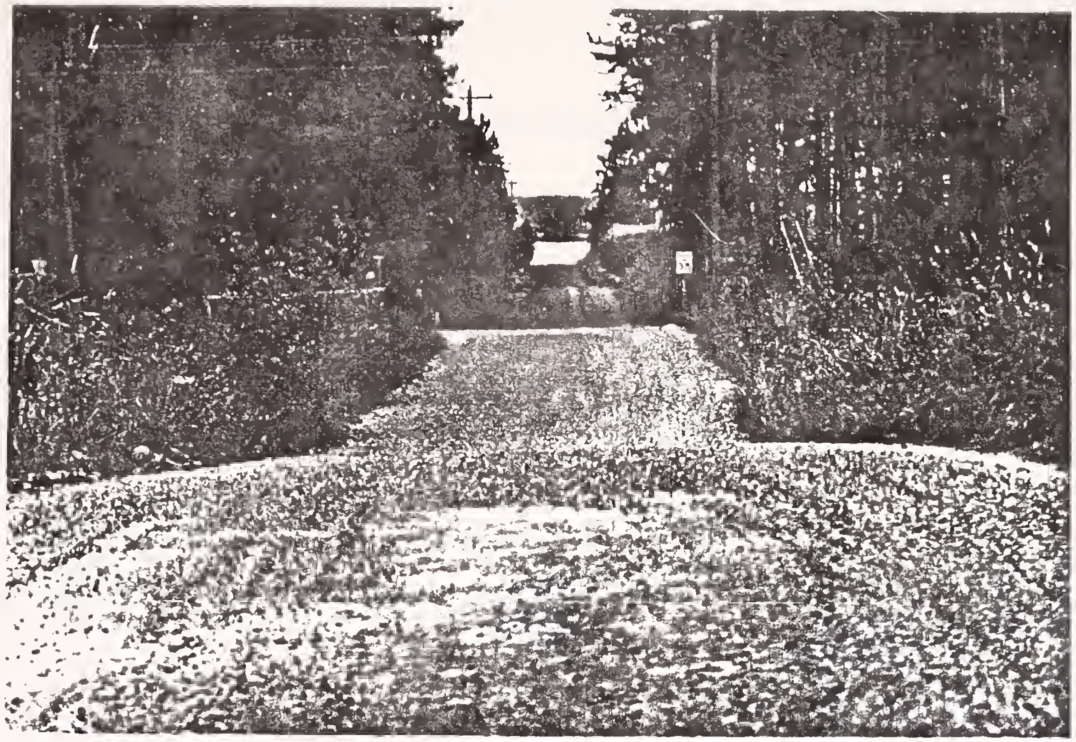
Pavement markings would help delineate lane assignments and control passing maneuvers.

The cost of these improvements is estimated to be approximately $3,390 based on 1989 unit bid contract prices and MDOH fund eligible prices. The pavement markings should be much less if the striping were to be completed as part of a county wide pavement marking program.

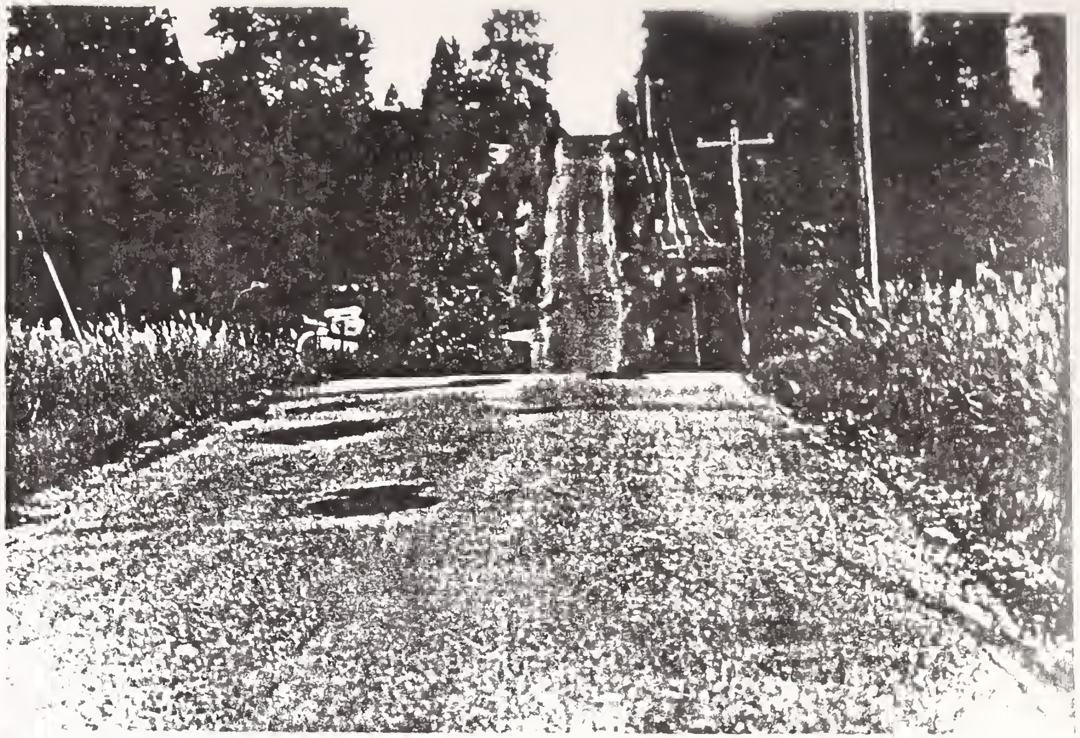
Long term improvements at this site cannot be foreseen until traffic volumes increase significantly. If traffic on this road continues to grow, complete reconstruction of the roadway would be necessary.

BENEFITS

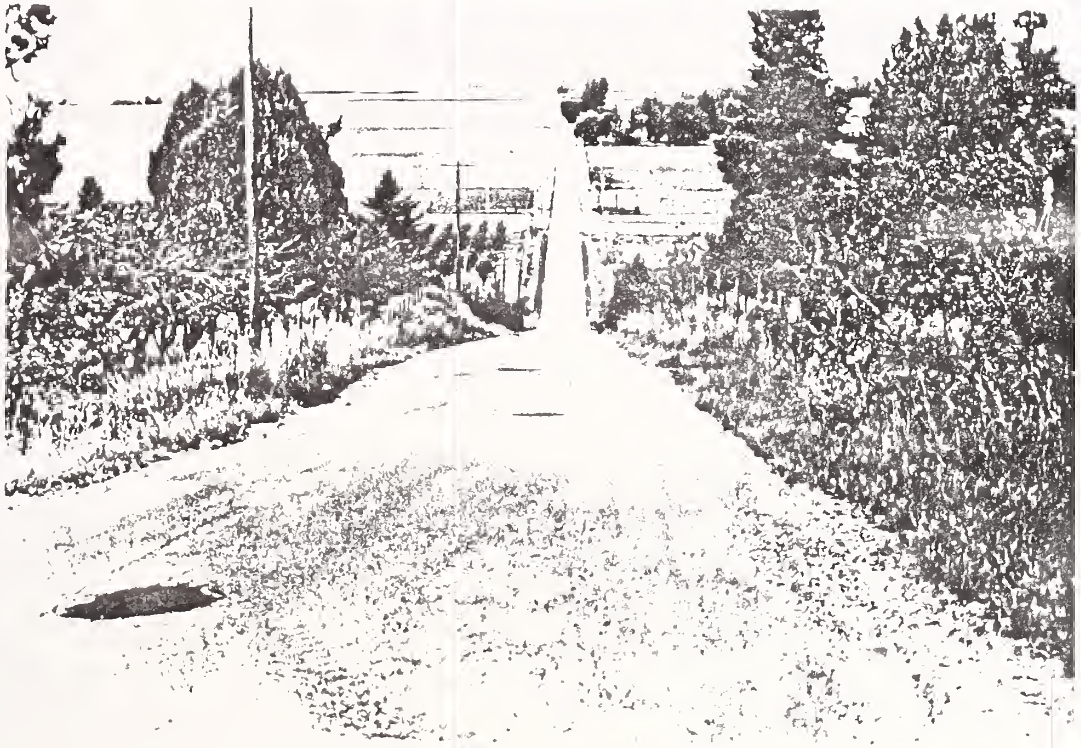
The annual dollar benefit that may be realized from the short term improvements is computed to be approximately $6,630 annually. The benefit/cost ratio is computed to be 5.12 according to methods developed by the Montana Department of Highways.



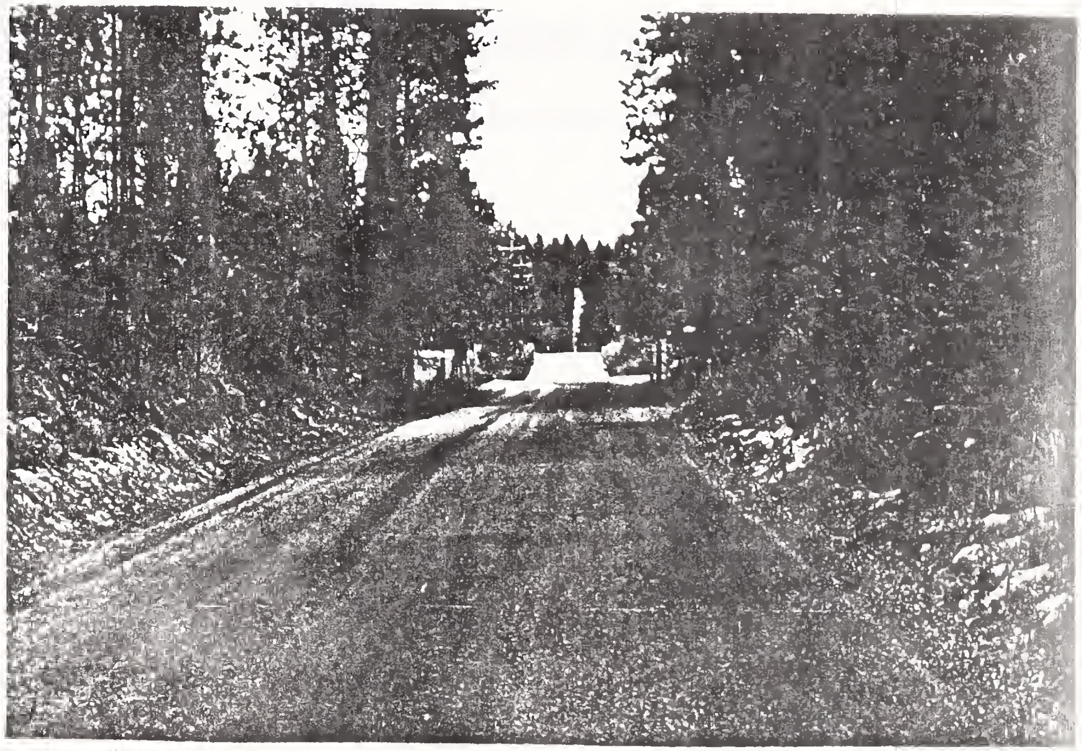
TURTLE LAKE RD @ DUPUIS, NORTHBOUND



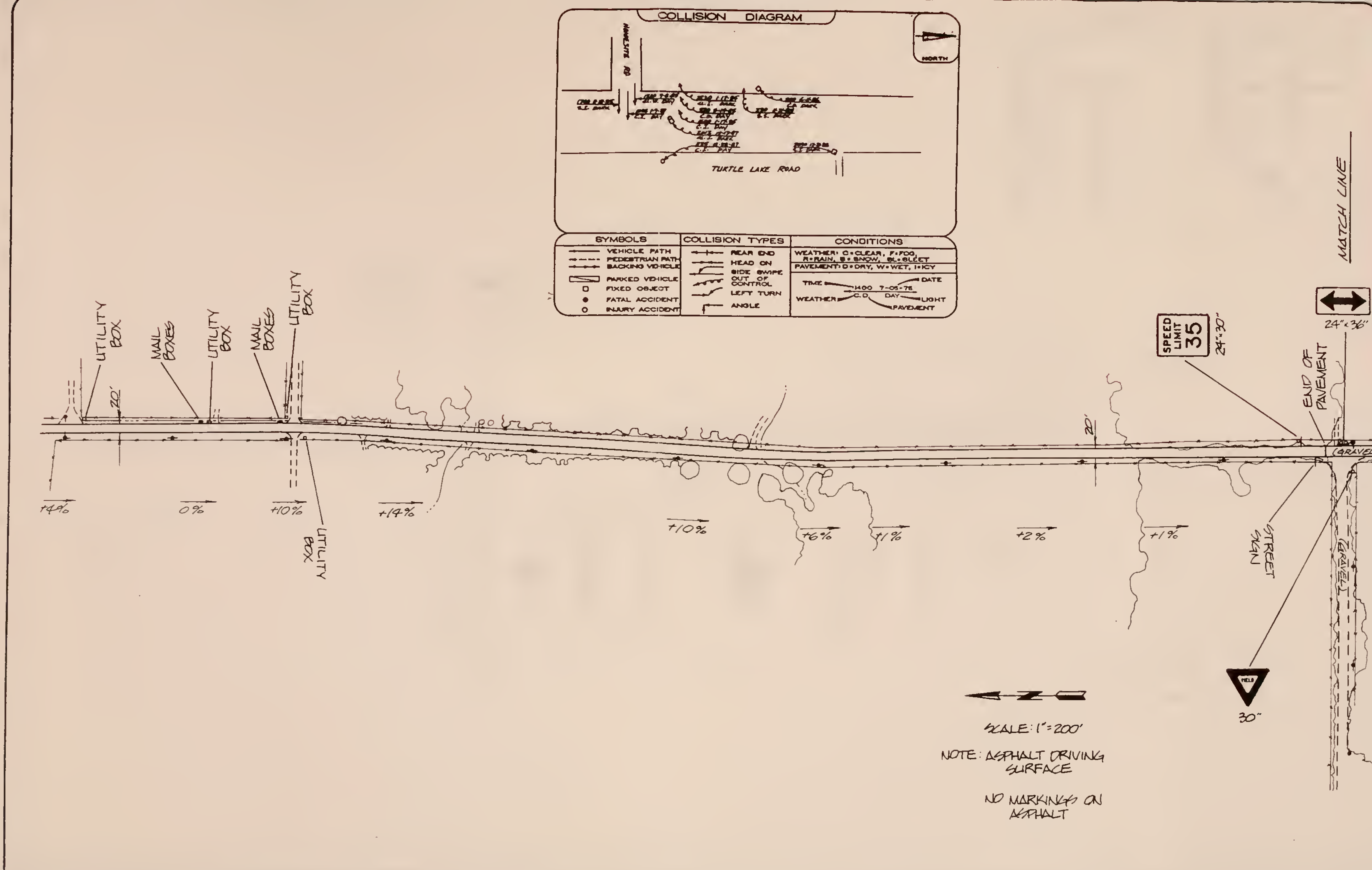
TURTLE LAKE RD BOT. OF HILL, SOUTHBOUND



TURTLE LAKE RD TOP OF HILL, NORTHBOUND



TURTLE LAKE RD N OF DUPUIS, SOUTHBOUND



MARVIN & ASSOCIATES Traffic Transportation & Civil Engineers SUITE 304 TRANSWESTERN I 404 N. 31st BILLINGS, MT 59107 Ph. (406) 248-5088	Project: LAKE COUNTY TRAFFIC SAFETY STUDY	Sheet Title: TURTLE LAKE ROAD EXISTING CONDITIONS	Surveyed By: Designed By: Drawn By: Checked By: Date Revisions: No. Date	Project No. Client No. Sheet No. 1 of

ACCIDENT STATISTICS - TURTLE LAKE ROAD

ACCIDENTS / YEAR :
1985 = 6
1986 = 1
1987 = 3
1988 = 1 TOTAL = 11

ACCIDENT TYPE - % OF TOTAL :
0 HEAD ON = 0%
3 ANGLE = 27%
0 LEFT TURN = 0%
0 SIDE SWP. = 0%
0 REAR END = 0%
8 SINGLE V = 73%
0 OTHER = 0%

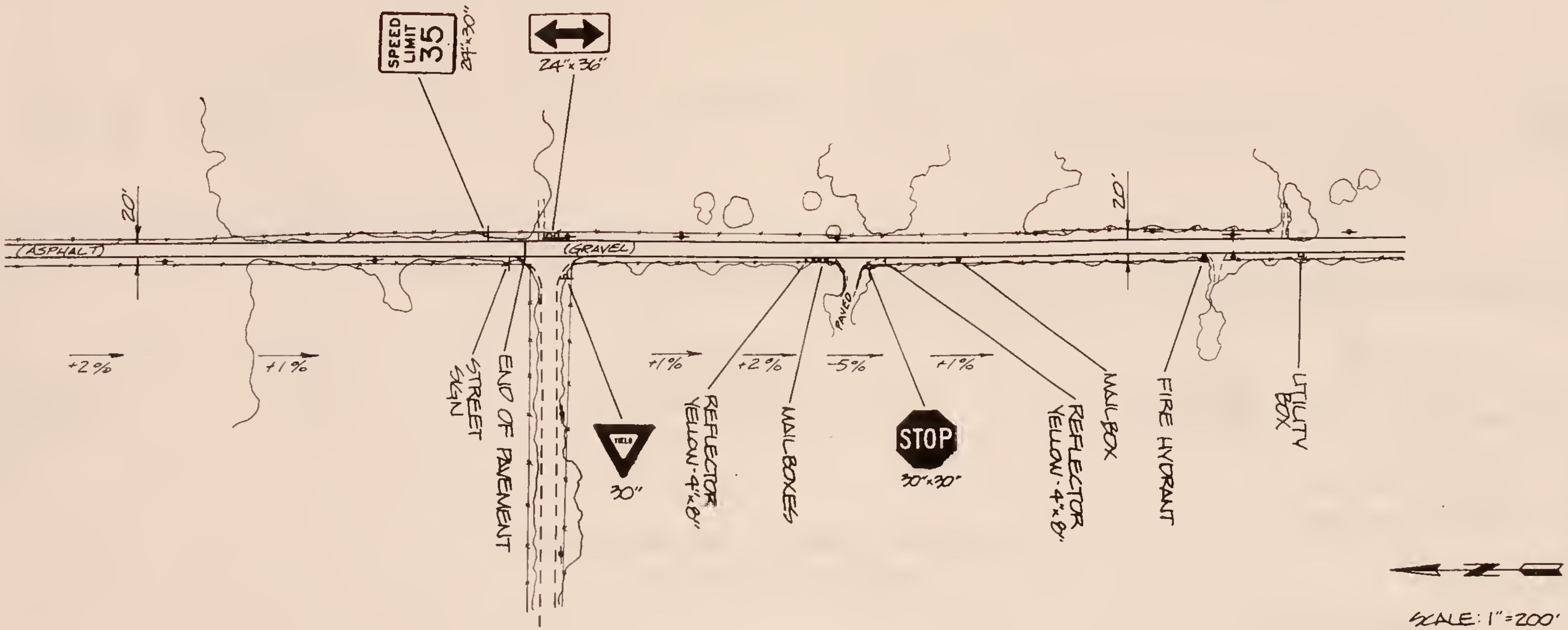
WEATHER CONDITIONS - % OF TOTAL :
8 CLEAR = 73%
0 RAIN = 0%
3 SNOW = 27%
0 FOG = 0%

ROAD CONDITIONS - % OF TOTAL :
2 DRY = 18%
1 WET = 9%
8 ICY = 73%

LIGHT CONDITIONS - % OF TOTAL :
6 DARK = 55%
5 DAY = 45%

SEVERITY - % OF TOTAL :
0 FATAL = 0%
2 INJURY = 18%
9 PROP DAM = 82%

ALCOHOL INVOLVED 3
% TOTAL = 27%



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Project: LAKE COUNTY TRAFFIC SAFETY STUDY

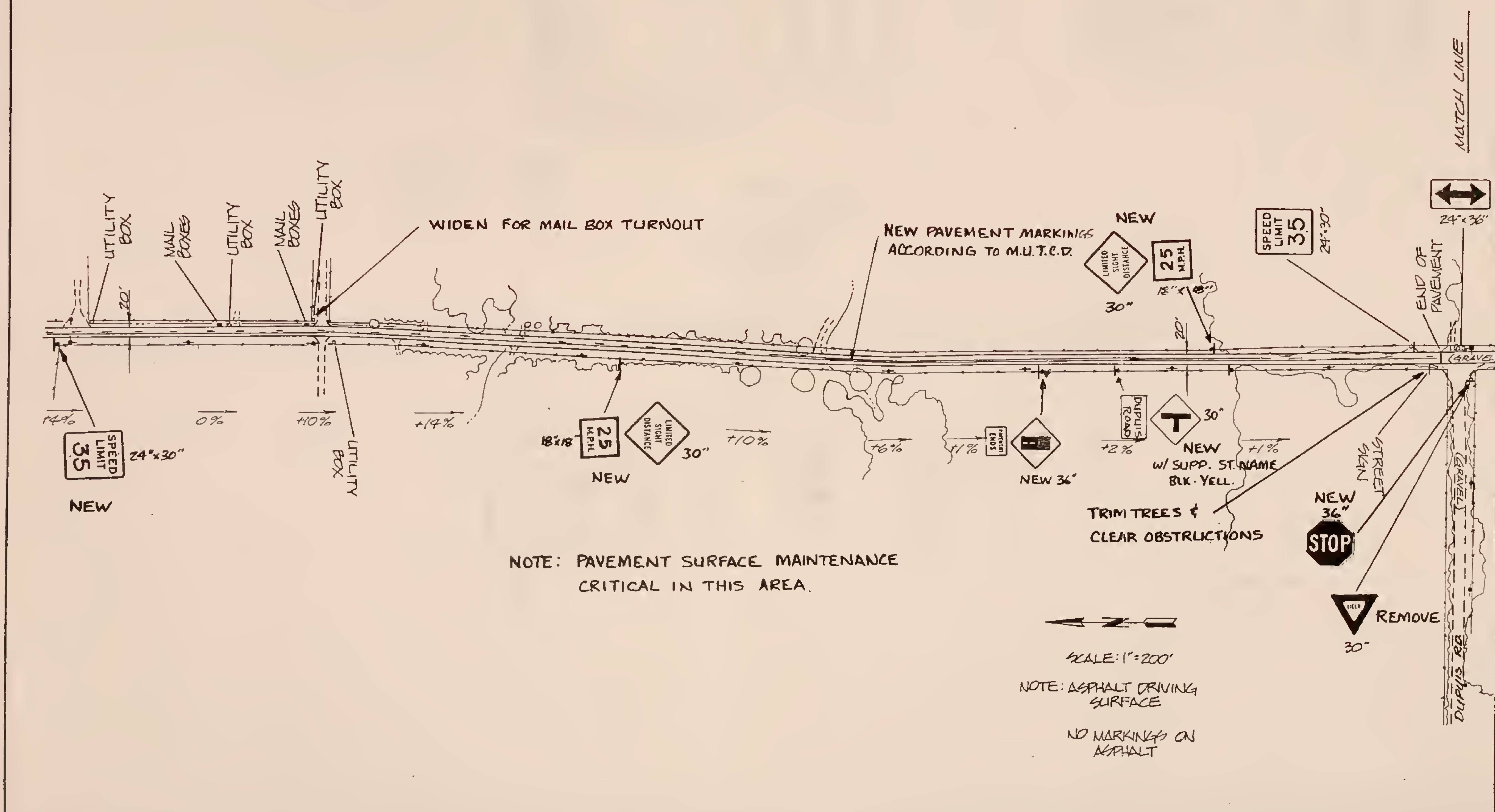
Sheet Title: TURTLE LAKE ROAD EXISTING CONDITIONS

Surveyed By:
Designed By:
Drawn By:
Checked By:
Date

Revisions
No. Date
No. Date
No. Date
No. Date

Project No.
Client No.

Sheet No. 2 of



MARVIN & ASSOCIATES Traffic Transportation & Civil Engineers SUITE 304 TRANSWESTERN I 404 N. 31st BILLINGS MT 59107 Ph. (406) 248-5088	Project: LAKE COUNTY TRAFFIC SAFETY STUDY	Sheet Title: TURTLE LAKE ROAD SHORT TERM IMPROVEMENTS	Surveyed By: Designed By: Drawn By: Checked By: Date	Revisions No. Date No. Date No. Date No. Date	Project No. Client No.	Sheet No. 1 of

SHORT TERM IMPROVEMENTS

ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : TURTLE LAKE ROAD

ACCIDENT TYPE	# ACC. IN PERIOD I/F	# ACC. IN PERIOD PD	EST. % CHANGE	CHANGE IN # ACC. I/F	CHANGE IN # ACC. PD
HEAD ON	0	0	0%	0.0	0.0
ANGLE	0	3	40%	0.0	1.2
LEFT TURN	0	0	0%	0.0	0.0
SIDE SWIPE	0	0	0%	0.0	0.0
REAR END	0	0	0%	0.0	0.0
SINGLE VEHICLE	2	6	30%	0.6	1.8
PEDESTRIAN	0	0	0%	0.0	0.0
OTHER	0	0	0%	0.0	0.0
TOTALS :	2	9	***	0.6	3.0

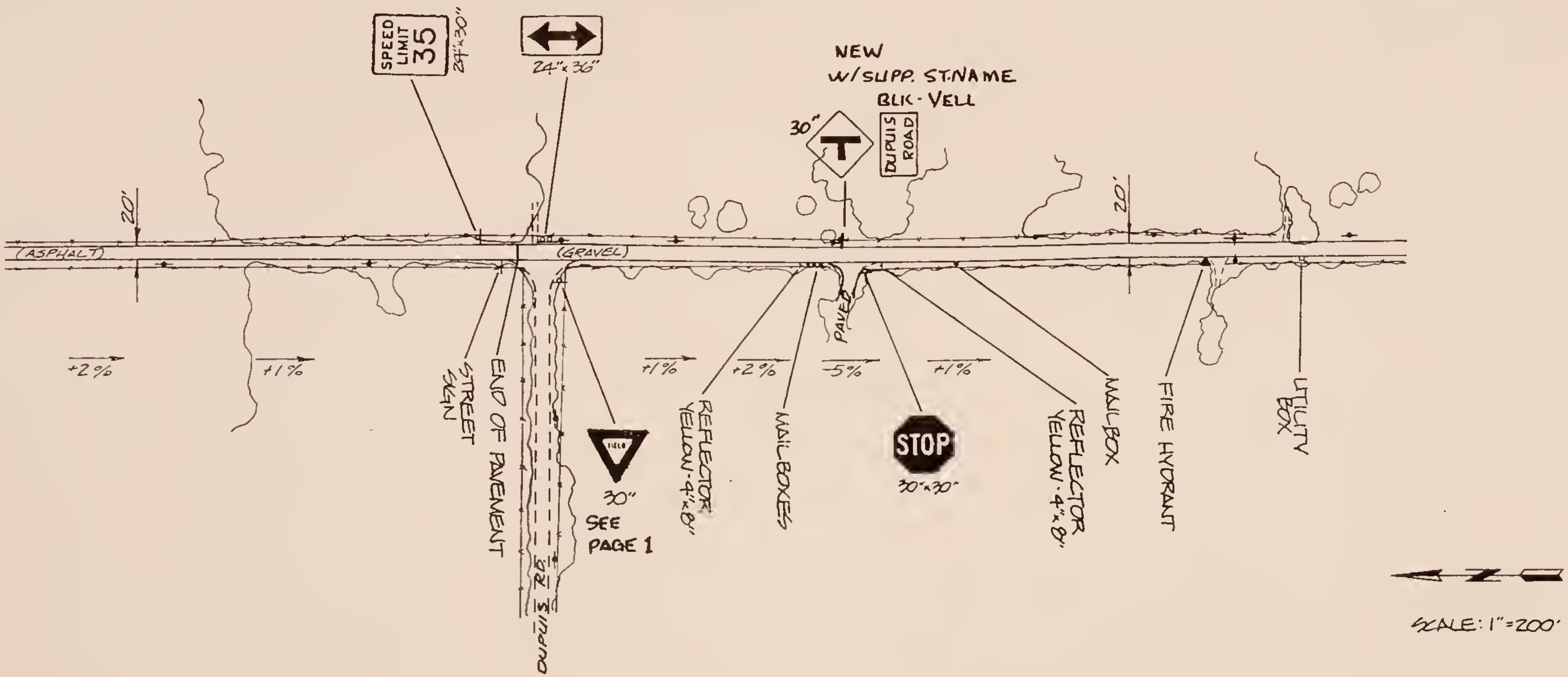
% REDUCTION IN INJURY/FATAL ACCIDENTS = 30.0%
% REDUCTION IN PROPERTY DAMAGE ACCIDENTS = 33.3%

TURTLE LAKE ROAD

IMPROVEMENT COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	NEW SIGNS (<6 SF)	1	Ea	$100.00	$100.00
2	NEW SIGNS (6.1 TO 10 SF)	5	Ea	$140.00	$700.00
3	NEW SUPPLEMENTARY SIGNS	5	Ea	$50.00	$250.00
4	RELOCATE SIGNS	0	Ea	$20.00	$0.00
5	REMOVE SIGNS	1	Ea	$20.00	$20.00
6	PAVE. MARKINGS (PAINT)	48	Gal	$25.00	$1,200.00
7	PAVE. MARKING PLASTIC	0	SF	$6.00	$0.00
8	DELINEATORS, FLEXIBLE	0	Ea	$20.00	$0.00
9	TRIM TREES	1	LS	$320.00	$320.00
10	EARTHWORK & RELATED IMP	1	LS	$800.00	$800.00

TOTAL CONSTRUCTION COSTS = $3,390.00



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Project: LAKE COUNTY TRAFFIC SAFETY STUDY

Sheet Title: TURTLE LAKE ROAD SHORT TERM IMPROVEMENTS

Surveyed By:
Designed By:
Drawn By:
Checked By:
Date:

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Sheet No. 2 of ___

SITE #8

OLD U.S. 93 CURVE S. OF PABLO
PRIORITY NUMBER 8

SITE DESCRIPTION

Old U.S. 93 is a north-south road which used to be part of the Highway 93 alignment before Highway 93 was reconstructed along an alignment which by-passed certain towns within Lake County. This section of Old U.S. 93 is approximately 1.0 miles south of Pablo, Montana. It serves as alternate access between Pablo and Ronan; as an access to local farms and residences; and as an alternate access to the town of Pablo from Highway 93.

The accident cluster area begins approximately 1.0 miles south of Pablo and extends south to an intersection with Highway 93, a distance of approximately 0.4 miles.

EXISTING CONDITIONS

Geometrics. The site geometrics are shown in the existing condition sketch. The accident cluster area is located at the curve, which is the only curve within an otherwise tangent section of roadway.

The roadway is paved 24 feet in width and has 4:1 side slopes and wide ditch sections. It was constructed to old primary highway standards. Superelevation of the road surface in the curve section is variable due to settlement and other conditions of the roadway. There is a vertical curve in the middle of the horizontal curve. The vertical and horizontal curves are not

coordinated and some degree of sight distance is lost. Vegetation growth at this site does not present any significant sight distance restrictions.

An approach road aligns with the southbound tangent extension of the curve. The geometrics at this location create a wide open intersection at the beginning of the curve.

Traffic Control Devices. The only traffic control devices in this section are stop signs at road approaches; delineators which were probably left over from the time it was a primary highway route; advanced curve warning signs, one of which is placed too close to the curve; and hazard markers on a bridge.

Traffic Volumes. The current traffic volume on this section of roadway is approximately 1,800 vehicles per day. Traffic volumes throughout the past four years have probably increased by approximately 3%. Machine recording counts were taken at a point 2.0 miles south of this location. The hourly variations indicate that traffic patterns on this road are extremely unusual. The peak hour is at 8:00 in the evening at 12% of average daily traffic. The second highest peak is at 4:00 in the afternoon with 10% of ADT. Two other peaks are at 12:00 midnight and at 10:00 in the morning. Traffic has extreme variations between these peaks. This indicates that there may be some specific type of traffic using this facility that involves shift work or some other highly intensive attraction. The directional split on Old U.S. 93 is approximately 40%-60% which means that at certain periods of the

day, 40% of the vehicles are going in one direction while the remainder are headed in the other.

Traffic Operations. No potential conflicts were observed on this section of roadway during the field review. However, from the Engineer's perspective during subjective evaluations at the site, it was noted that several factors have combined to create potential problems at this site.

1. The curves in the alignment presents a significantly different change in the otherwise straight alignment of the roadway in the southbound direction. The approach road in the southbound direction appears to be a continuation of the highway and because the intersection occupies so much shoulder distance, the delineators do not help to define the curve even at night.

2. The variation in superelevation in the middle of the curves tends to rock the vehicle. In an emergency situation, this action could be enough to cause loss of control.

3. The curve alignment is not visible in the northbound direction because the vertical curve hides the horizontal curve.

Accidents. The collision diagram and accident statistics tables shown on the existing condition sketch indicates that there were seven accidents recorded in the four year study period. The accidents seem to reflect the conditions encountered at the site. All of the accidents are single vehicle accidents consistent with loss of control on the curves.

All of the accidents occurred on dry roads in fair weather

conditions. Almost all of the accidents occurred during night time hours. The accidents all occurred between late summer and mid fall.

The severity of accidents at this site is uncharacteristically low with only 29% of the accidents producing injuries. The possible reason for this would be the lack of significant roadside hazards and flat ditch slopes.

SHORT TERM IMPROVEMENTS

Suggested improvements at this site strive to reduce the effects of the above noted problems. Over sized curve warning signs are considered necessary to draw more attention in advance of the curves. Proper delineation of the roadway path is especially critical at this site especially at night. It is felt that the chevron signs will provide a higher degree of curve delineation Pavement markings combined with delineators will over come the other physical roadway alignment miscues under most circumstances.

Realignment of the existing approach at the beginning of the curve is a key condition for proper delineation of the curve. Paving of the relocated approach will help reduce the incidence of gravel on the paved surface, which will help vehicle control.

The cost of these improvements is estimated to be approximately $4,330 based on 1989 unit bid contract prices and MDOH fund eligible prices. The grading, paving and pavement

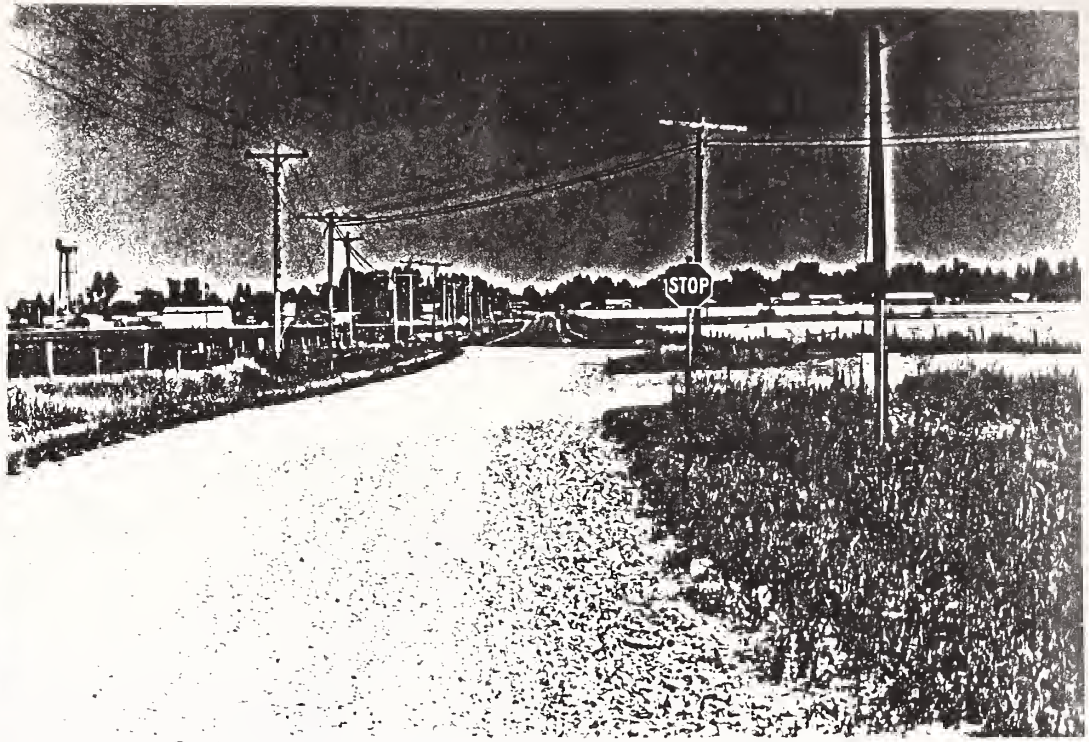
markings should be much less if county crews performed the work and the striping were to be completed as part of a county wide pavement marking program.

Long term improvements at this site cannot be foreseen nor should they be anticipated until traffic volumes increase beyond 4,000 ADT.

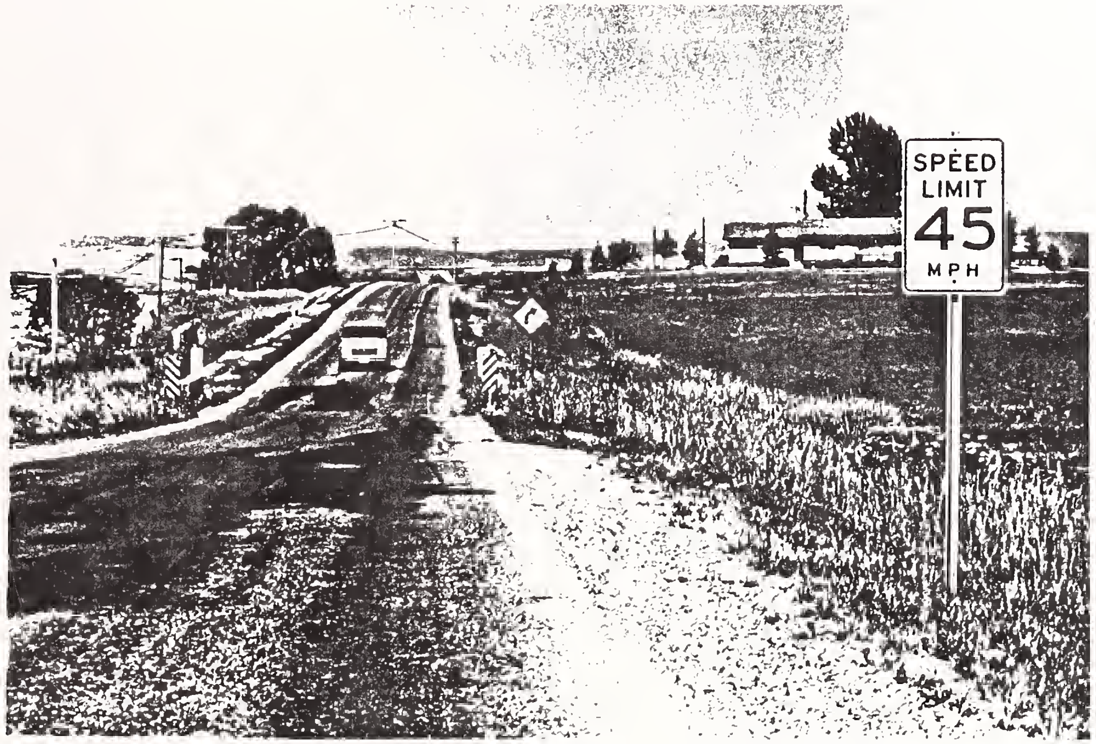
BENEFITS

The annual dollar benefit that may be realized from the short term improvements is computed to be approximately $8,083 annually. The benefit/cost ratio is computed according to accepted methods at 6.78.

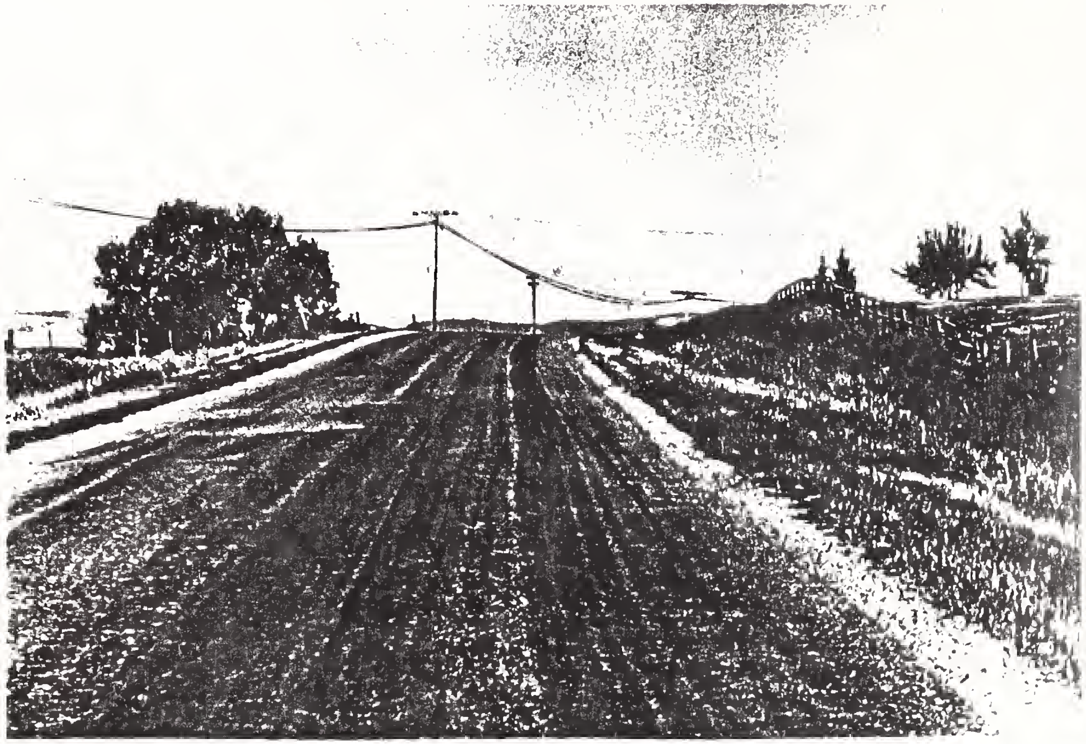
OLD US 93 S PABLO, SOUTHBOUND



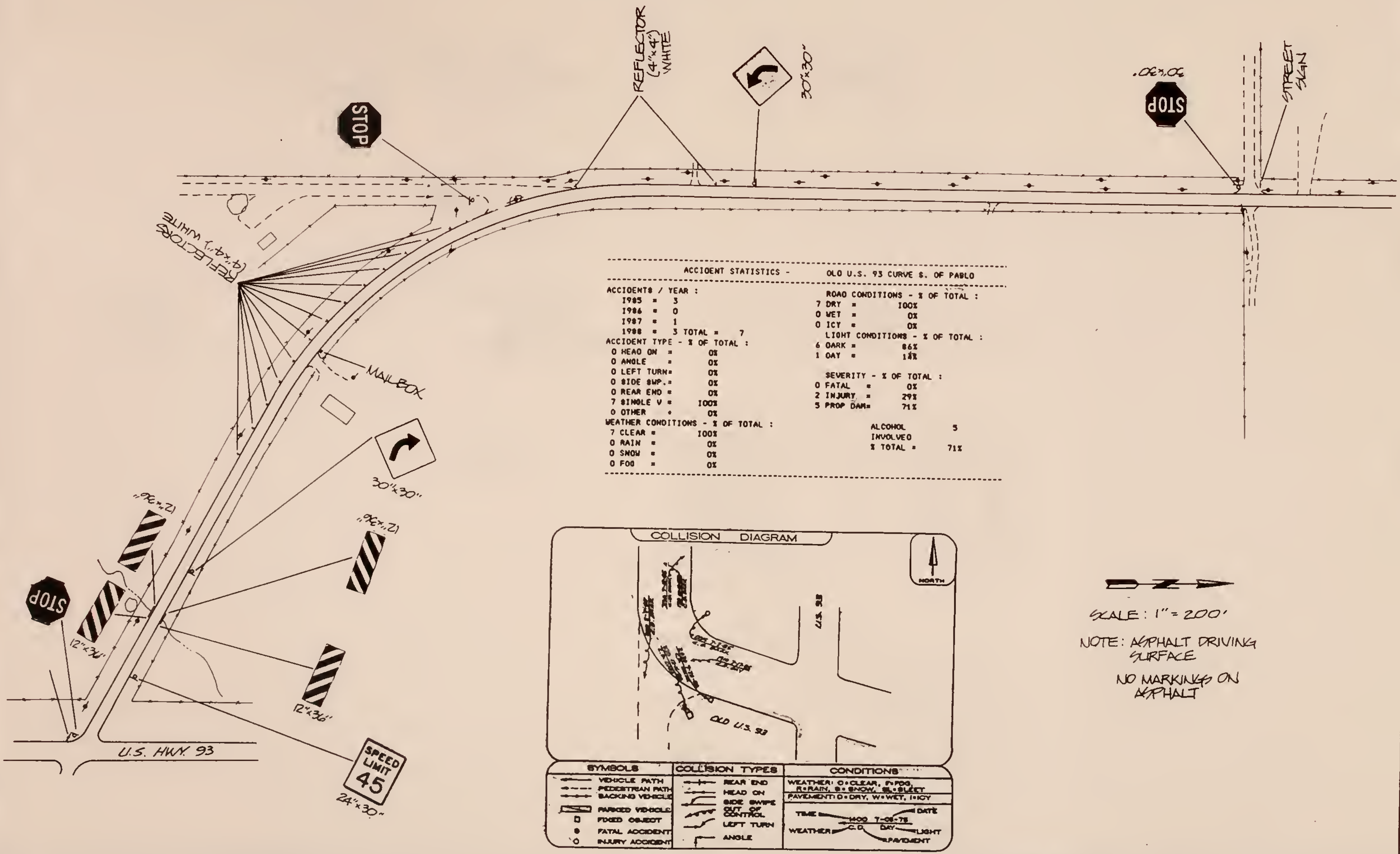
OLD US 93 CURVE S PABLO, NORTHBOUND



OLD US 93 CURVE S PABLO, WESTBOUND



OLD US 93 CURVE S PABLO, WESTBOUND



ACCIDENT STATISTICS - OLD U.S. 93 CURVE S. OF PABLO

ACCIDENTS / YEAR :
1985 = 3
1986 = 0
1987 = 1
1988 = 3 TOTAL = 7

ACCIDENT TYPE - % OF TOTAL :
0 HEAD ON = 0%
0 ANGLE = 0%
0 LEFT TURN= 0%
0 SIDE SWP.= 0%
0 REAR END = 0%
7 SINGLE V = 100%
0 OTHER = 0%

WEATHER CONDITIONS - % OF TOTAL :
7 CLEAR = 100%
0 RAIN = 0%
0 SNOW = 0%
0 FOG = 0%

ROAD CONDITIONS - % OF TOTAL :
7 DRY = 100%
0 WET = 0%
0 ICY = 0%

LIGHT CONDITIONS - % OF TOTAL :
6 DARK = 86%
1 DAY = 14%

SEVERITY - % OF TOTAL :
0 FATAL = 0%
2 INJURY = 29%
5 PROP DAM= 71%

ALCOHOL INVOLVED 5
% TOTAL = 71%

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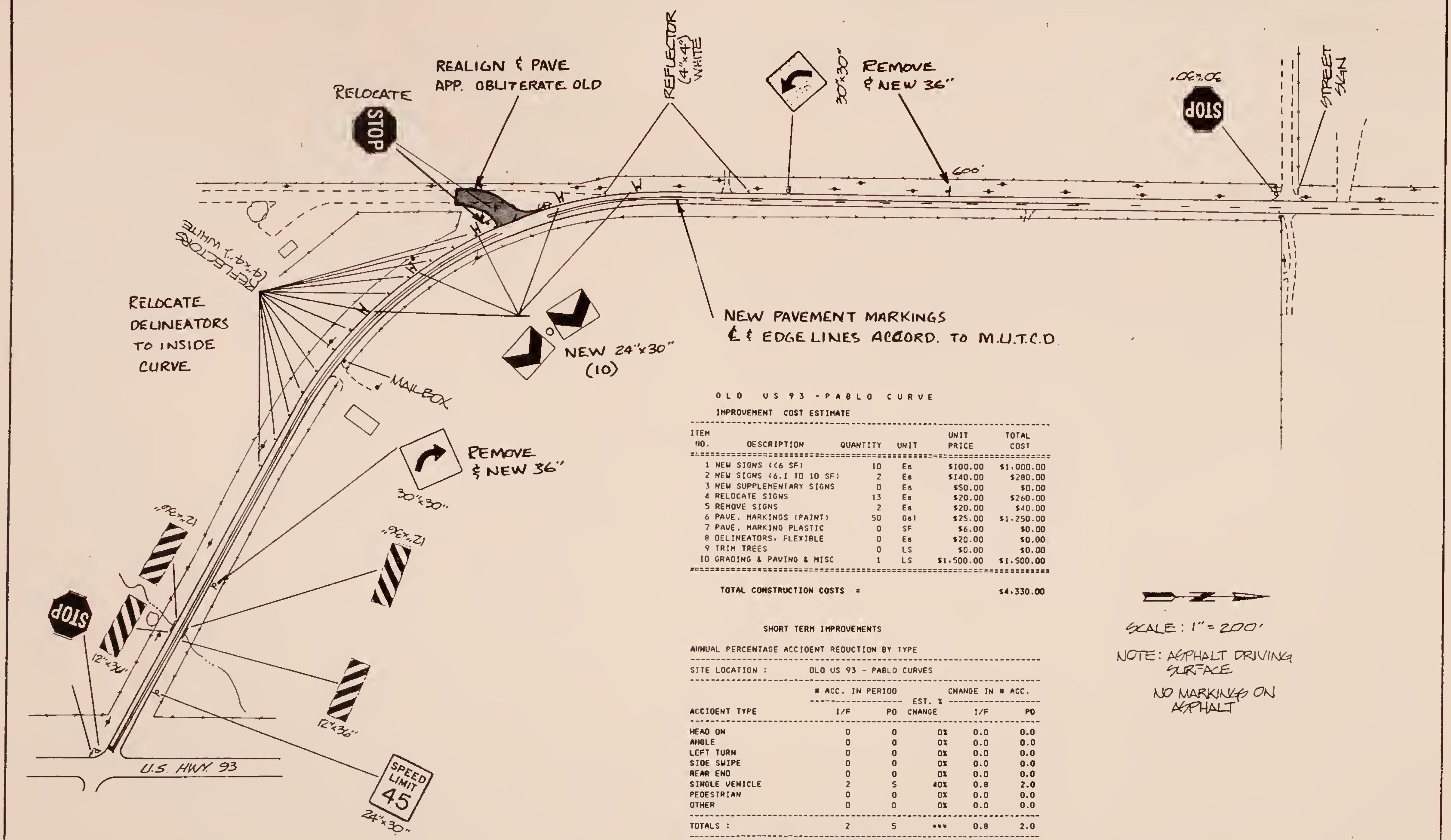

OLD US 93 - PABLO CURVE

IMPROVEMENT COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	NEW SIGNS (<6 SF)	10	Ea	$100.00	$1,000.00
2	NEW SIGNS (6.1 TO 10 SF)	2	Ea	$140.00	$280.00
3	NEW SUPPLEMENTARY SIGNS	0	Ea	$50.00	$0.00
4	RELOCATE SIGNS	13	Ea	$20.00	$260.00
5	REMOVE SIGNS	2	Ea	$20.00	$40.00
6	PAVE. MARKINGS (PAINT)	50	Gal	$25.00	$1,250.00
7	PAVE. MARKING PLASTIC	0	SF	$6.00	$0.00
8	DELINEATORS, FLEXIBLE	0	Ea	$20.00	$0.00
9	TRIM TREES	0	LS	$0.00	$0.00
10	GRADING & PAVING & MISC	1	LS	$1,500.00	$1,500.00

TOTAL CONSTRUCTION COSTS = $4,330.00

SHORT TERM IMPROVEMENTS

ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : OLD US 93 - PABLO CURVES

ACCIDENT TYPE	# ACC. IN PERIOD I/F	# ACC. IN PERIOD PD	EST. % CHANGE	CHANGE IN # ACC. I/F	CHANGE IN # ACC. PD
HEAD ON	0	0	0%	0.0	0.0
ANGLE	0	0	0%	0.0	0.0
LEFT TURN	0	0	0%	0.0	0.0
SIDE SWIPE	0	0	0%	0.0	0.0
REAR END	0	0	0%	0.0	0.0
SINGLE VEHICLE	2	5	40%	0.8	2.0
PEDESTRIAN	0	0	0%	0.0	0.0
OTHER	0	0	0%	0.0	0.0
TOTALS :	2	5	***	0.8	2.0

% REDUCTION IN INJURY/FATAL ACCIDENTS = 40.0%
% REDUCTION IN PROPERTY DAMAGE ACCIDENTS = 40.0%

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Project: LAKE COUNTY TRAFFIC SAFETY STUDY

Sheet Title: OLD U.S. 93 - PABLO CURVE SHORT TERM IMPROVEMENTS

Surveyed By :
Designed By :
Drawn By :
Checked By :
Date :

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Client No.

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SITE #9

ROCKY POINT ROAD
PRIORITY NUMBER 9

SITE DESCRIPTION

Rocky Point Road is a north-south road which used to be part of the state secondary road system. It begins at an intersection with Highway 93 1.0 miles west of Polson, Montana and extends north approximately seven miles. It serves as the only access to small farms and hundreds of residences and summer homes along the west shore of Flathead Lake.

The accident cluster area begins approximately 1.6 miles north of Highway 93 and extends north approximately 0.6 miles.

EXISTING CONDITIONS

Geometrics. The site geometrics are shown in the existing condition sketch. The accident cluster area is located near the curve, which is the only curve within an otherwise tangent section of roadway, and along the tangent section preceding the curve in the northbound direction.

The roadway is paved 28 feet in width and has variable side slopes and ditch sections. It was constructed to old primary highway standards. The majority of the road is flat except at the northern end of the site where a 4-5% grade begins. Vegetation growth at this site does not present any significant sight distance restrictions. However, a berm on the inside of the curve is just big enough to effectively block intersection sight

distance to the north from the Bay Point Road approach.

Numerous driveway approaches to houses lining the roadway in the southern portion of this site exist. Trees and other fixed objects are sufficiently clear of the road surface so as to not restrict sight distance.

Traffic Control Devices. The only traffic control devices in this section are a stop signs at road approaches and speed limit signs (45 mph). Pavement markings existing at this site seem to be correctly applied.

Traffic Volumes. The current traffic volume on this section of roadway is approximately 1,350 vehicles per day. Traffic volumes throughout the past four years have probably increased by approximately 3%. Traffic volumes on Bay Point Road are approximately 300 vehicles per day. Lake County was not able to provide historic traffic volumes at this location. The directional split is approximately 40%-60% which means that at certain periods of the day, 40% of the vehicles are going in one direction while the remainder are headed in the other.

Traffic Operations. No potential conflicts were observed on this section of roadway during the field review. However, from the Engineer's perspective during subjective evaluations at the site, it was noted that several factors have combined to create potential problems at this site.

1. The pavement surface is wider and flatter than most county roads and the roadside environment is relatively clear. The road shoulder is not well defined in the daytime and is worse at night.

2. In these conditions, vehicles speeds would be much greater than the 45 mph limit.

3. Intersection sight distance at Bay Point Road to the north is restricted by the road berm.

4. The intersection approach to Bay Point Road is not noticeable to either driver wishing to turn or to approaching vehicles intending to go straight.

Accidents. The collision diagram and accident statistics tables shown on the existing condition sketch indicates that there were seven accidents recorded in the four year study period. The majority of accidents are single vehicle accidents one of which was related to loss of control at the Bay Point intersection and the remaining two were a side-swipe and a rear-end, both at the intersection.

Most of the accidents occurred on dry roads in fair weather conditions. However, three of the accidents occurred on icy roads. The lighting conditions were fairly well split between day and night time. The severity of accidents at this site is slightly high with 57% of the accidents producing injuries.

SHORT TERM IMPROVEMENTS

Suggested improvements at this site strive to reduce the effects of the above noted problems. Over sized intersection warning signs are considered necessary to draw more attention in advance of the Bay Point intersection. Use of the supplementary street name plates in advance of the curve will help drivers locate the road approach and properly plan the turn maneuver.

Proper delineation of the roadway shoulders is important at this site especially at night. It is felt that the continuous delineation through this section of road will provide a better perspective of where the shoulders are located. Pavement edge lines combined with the delineators will provide positive guidance in most weather conditions.

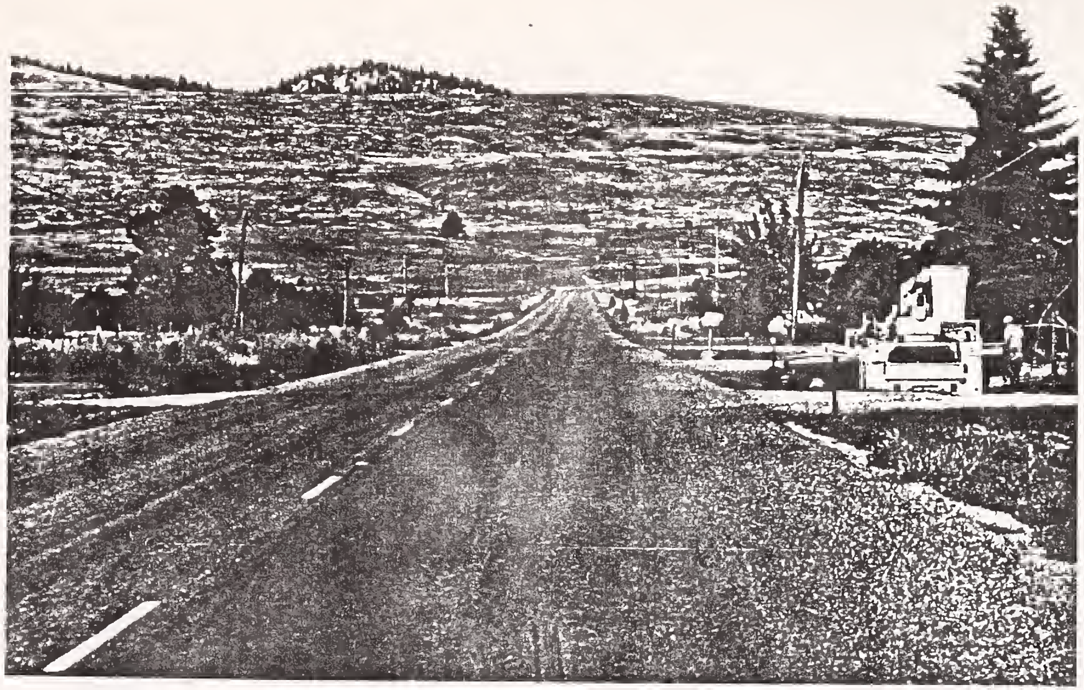
Grading on the inside curve berm will provide the necessary intersection sight distance for Bay point Road approach traffic. This will eliminate a potentially hazardous condition at this site.

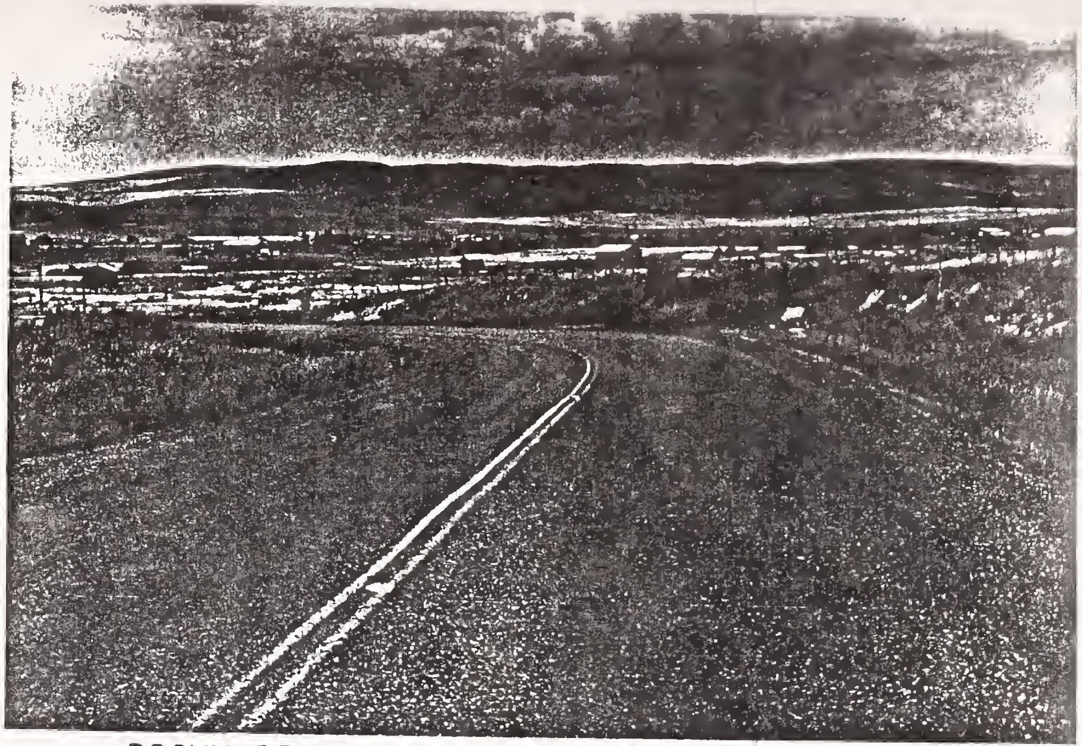
The cost of these improvements is estimated to be approximately $7,165 based on 1989 unit bid contract prices and MDOH fund eligible prices. The grading, and pavement markings should be much less if county crews performed the work and the striping were to be completed as part of a county wide pavement marking program.

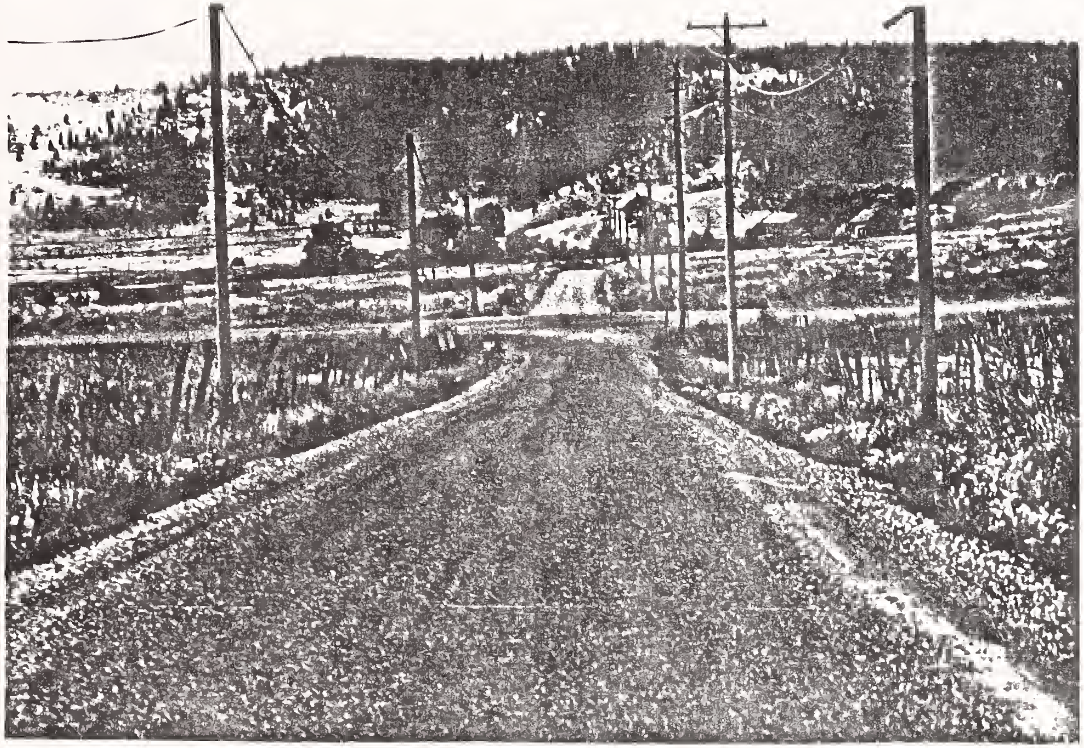
Long term improvements at this site cannot be foreseen nor should they be anticipated until traffic volumes increase beyond 4,000 ADT.

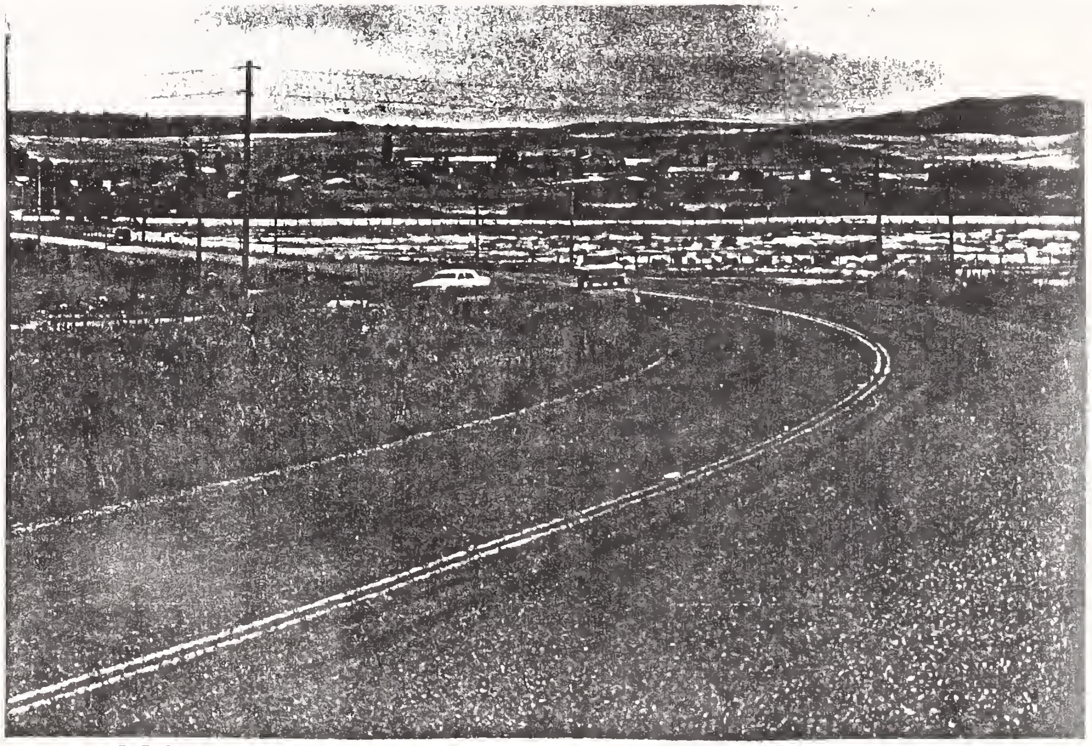
BENEFITS

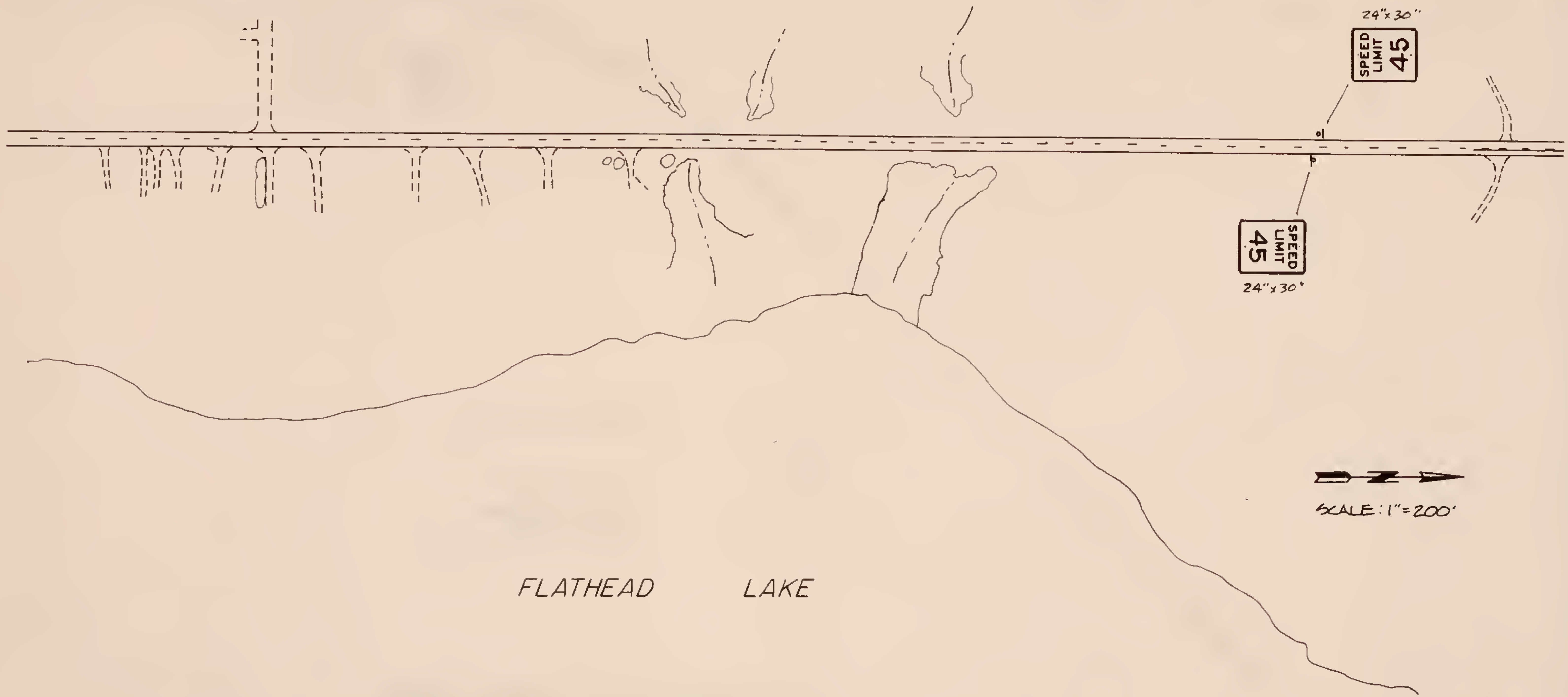
The annual dollar benefit that may be realized from the short term improvements is computed to be approximately $12,044 annually. The benefit/cost ratio is computed according to accepted methods at 6.05.


ROCKY POINT RD BEG SITE, NORTHBOUND


ROCKY POINT RD END SITE, SOUTHBOUND


ROCKY POINT RD ON BAY POINT, WESTBOUND


ROCKY POINT RD @ BAY POINT RD, SOUTHBOUND



MARVIN & ASSOCIATES Traffic Transportation & Civil Engineers SUITE 304 TRANSWESTERN I 404 N. 31st BILLINGS, MT 59107 Ph. (406) 248-5088	Project: LAKE COUNTY TRAFFIC SAFETY STUDY	Sheet Title: ROCKY POINT ROAD EXISTING CONDITIONS	Surveyed By: Designed By: Drawn By: Checked By: Date	Revisions No. Date No. Date No. Date No. Date	Project No. Client No.	Sheet No. 1 of

ACCIDENT STATISTICS - ROCKY POINT ROAD

ACCIDENTS / YEAR :
1985 = 2
1986 = 2
1987 = 1
1988 = 2 TOTAL = 7

ACCIDENT TYPE - % OF TOTAL :
0 HEAD ON = 0%
0 ANGLE = 0%
0 LEFT TURN= 0%
1 SIDE SWP.= 14%
1 REAR END = 14%
5 SINGLE V = 71%
0 OTHER = 0%

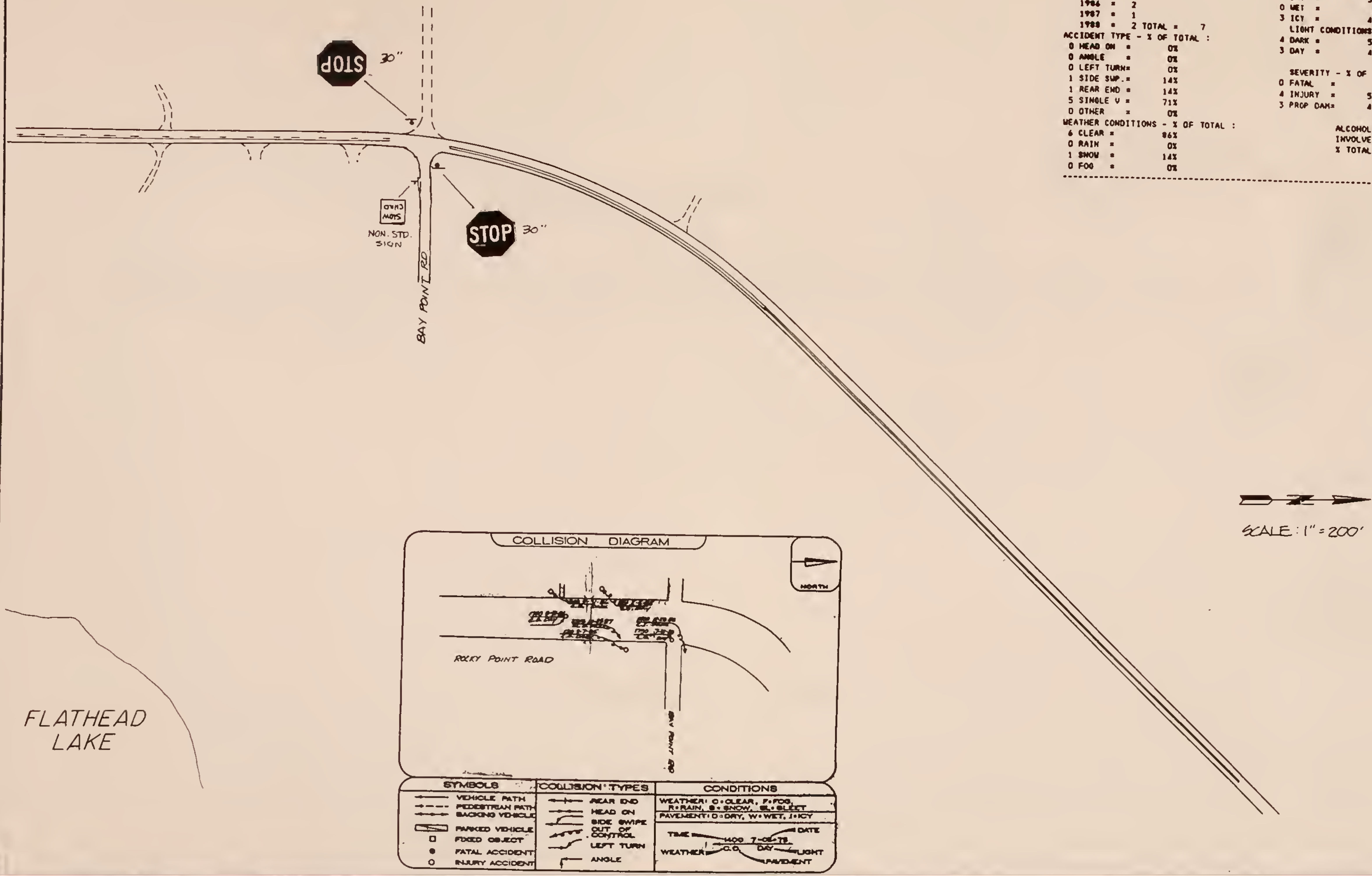
WEATHER CONDITIONS - % OF TOTAL :
6 CLEAR = 86%
0 RAIN = 0%
1 SNOW = 14%
0 FOG = 0%

ROAD CONDITIONS - % OF TOTAL :
4 DRY = 57%
0 WET = 0%
3 ICY = 43%

LIGHT CONDITIONS - % OF TOTAL :
4 DARK = 57%
3 DAY = 43%

SEVERITY - % OF TOTAL :
0 FATAL = 0%
4 INJURY = 57%
3 PROP DAM= 43%

ALCOHOL INVOLVED 2
% TOTAL = 29%



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Project : LAKE COUNTY TRAFFIC SAFETY STUDY

Sheet Title : ROCKY POINT ROAD EXISTING CONDITIONS

Surveyed By :
Designed By :
Drawn By :
Checked By :
Date :

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Client No.

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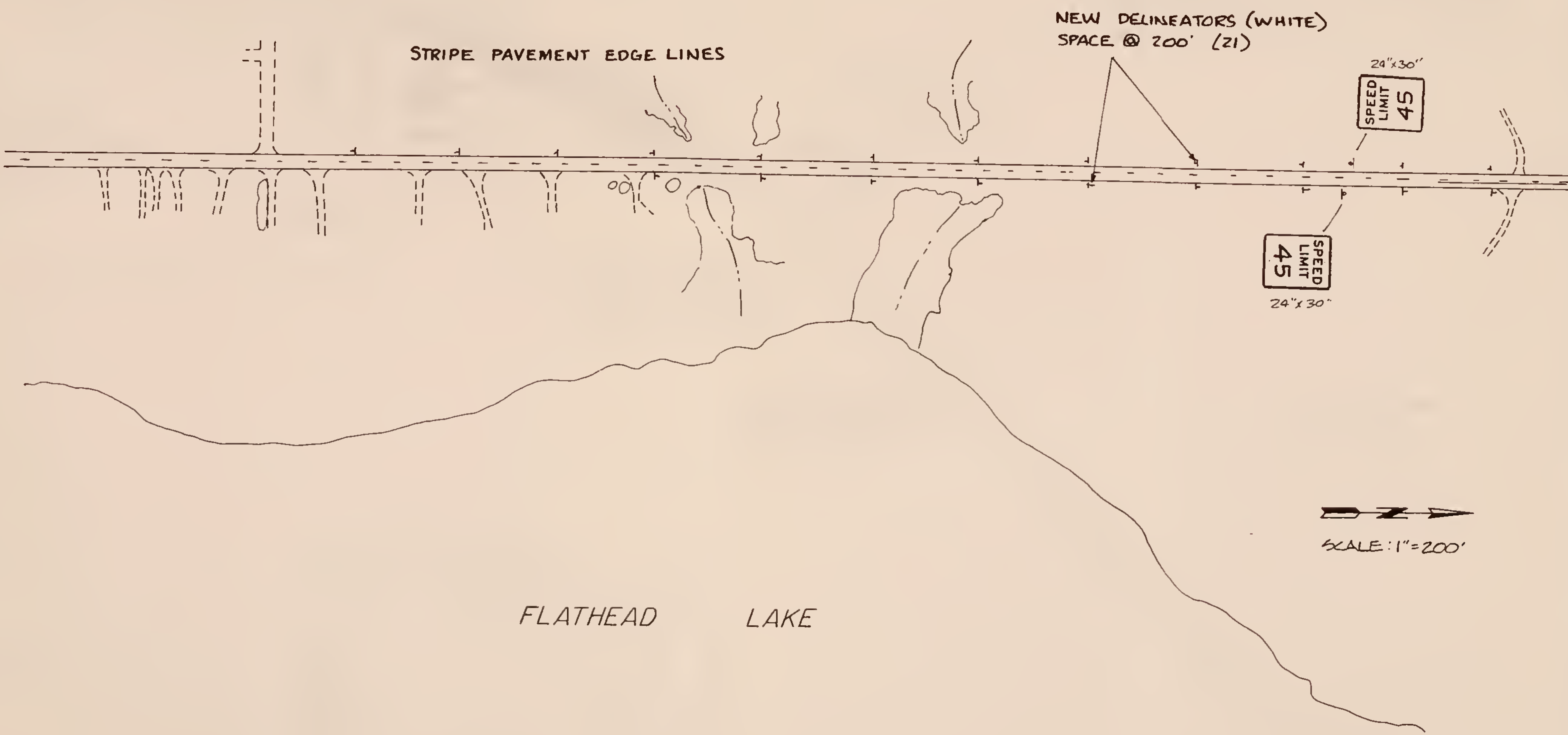

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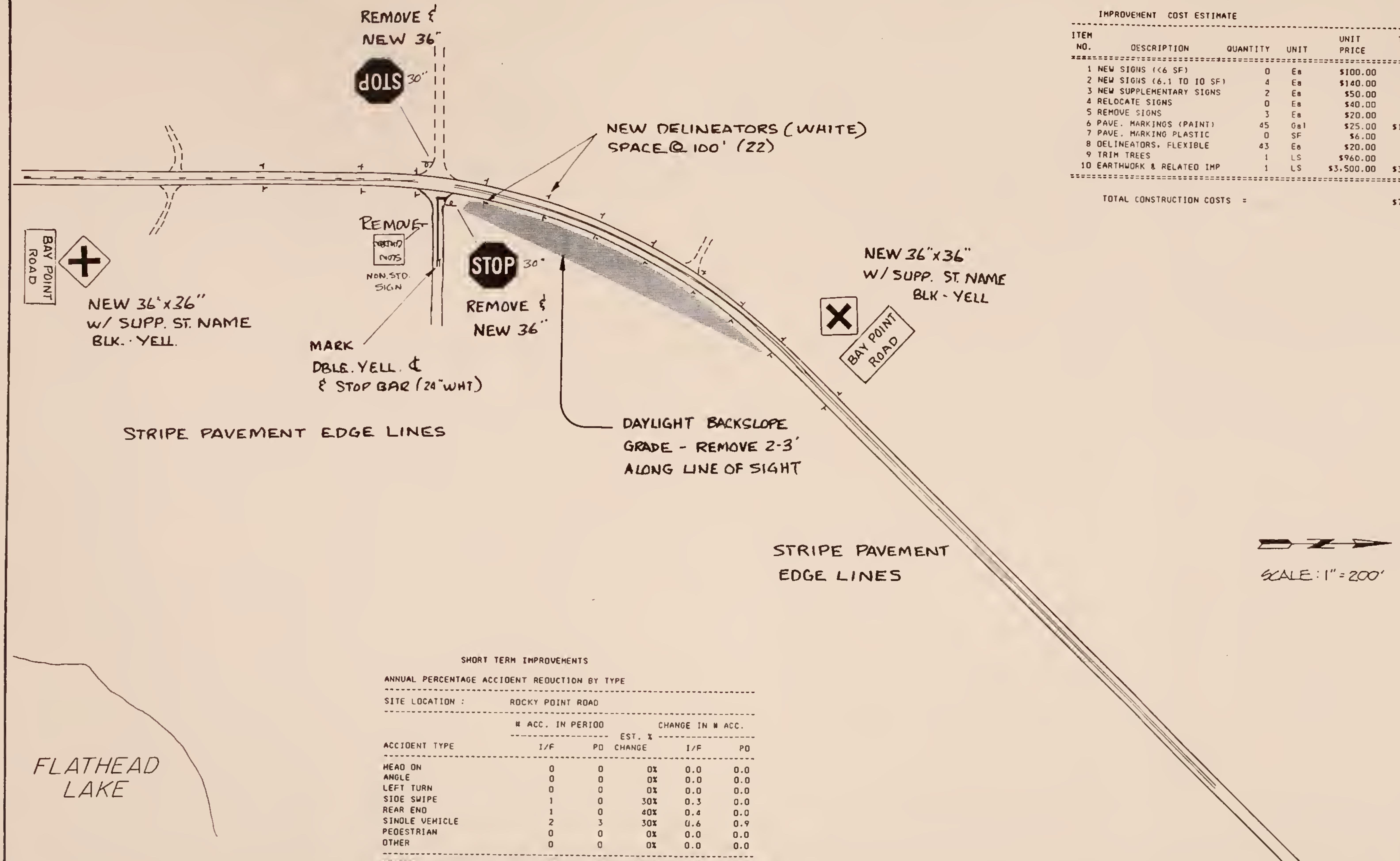
ROCKY POINT ROAD

IMPROVEMENT COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	NEW SIGNS (<6 SF)	0	Ea	$100.00	$0.00
2	NEW SIGNS (6.1 TO 10 SF)	4	Ea	$140.00	$560.00
3	NEW SUPPLEMENTARY SIGNS	2	Ea	$50.00	$100.00
4	RELOCATE SIGNS	0	Ea	$40.00	$0.00
5	REMOVE SIGNS	3	Ea	$20.00	$60.00
6	PAVE. MARKINGS (PAINT)	45	Gal	$25.00	$1,125.00
7	PAVE. MARKING PLASTIC	0	SF	$6.00	$0.00
8	DELINEATORS, FLEXIBLE	43	Ea	$20.00	$860.00
9	TRIM TREES	1	LS	$960.00	$960.00
10	EARTHWORK & RELATED IMP	1	LS	$3,500.00	$3,500.00

TOTAL CONSTRUCTION COSTS = $7,165.00



SHORT TERM IMPROVEMENTS

ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : ROCKY POINT ROAD

ACCIDENT TYPE	# ACC. IN PERIOD I/F	# ACC. IN PERIOD PD	EST. % CHANGE	CHANGE IN # ACC. I/F	CHANGE IN # ACC. PD
HEAD ON	0	0	0%	0.0	0.0
ANGLE	0	0	0%	0.0	0.0
LEFT TURN	0	0	0%	0.0	0.0
SIDE SWIPE	1	0	30%	0.3	0.0
REAR END	1	0	40%	0.4	0.0
SINGLE VEHICLE	2	3	30%	0.6	0.9
PEDESTRIAN	0	0	0%	0.0	0.0
OTHER	0	0	0%	0.0	0.0
TOTALS :	[illegible]	3	***	1.3	0.9

% REDUCTION IN INJURY/FATAL ACCIDENTS = 32.5%

% REDUCTION IN PROPERTY DAMAGE ACCIDENTS = 30.0%

SITE #10

FINLEY POINT ROAD
PRIORITY NUMBER 10

SITE DESCRIPTION

Finley Point Road is a rural road which serves as an access to cherry orchards, residences and summer homes on the east shore of Flathead Lake. It begins at an intersection with Highway 35 approximately 7 miles east of Polson and proceeds in a north westerly direction. It split into two roads that circles a finger of land that juts into Flathead Lake for about 5 miles.

The accident cluster area begins approximately just west of the Highway 35 intersection and extends west approximately 0.5 miles.

EXISTING CONDITIONS

Geometrics. The site geometrics are shown in the existing condition sketch. The accident cluster area is located along the tangent section of road and at the east end of the 90 degree turn.

The roadway is paved 20 feet in width and has variable side slopes and ditch sections. The roadway has a rolling vertical alignment with various dips and crests along its length. Grades range from 1% to 9%. There are numerous deciduous trees and brush along its length which tends to over grow onto the roadway.

A sharp 90 degree turn at the western end of the site is complicated by the presence of approach roads coming off the paved road in both directions. A steep grade and sharp vertical curve

follows this turn to the north. The pavement surface is in poor condition.

Traffic Control Devices. The only traffic control devices in this section are a stop sign at the approach to Highway 35, a speed limit sign (35 mph) for westbound traffic and a non standard "Do Not Pass" sign at the end of the site for northbound traffic. There are no existing pavement markings in this area.

Traffic Volumes. The current traffic volume on this section of roadway is approximately 1,600 vehicles per day. Traffic volumes throughout the past four years have probably increased by approximately 3%. Lake County was not able to provide historic traffic volumes at this location. The directional split is approximately 40%-60% which means that at certain periods of the day, 40% of the vehicles are going in one direction while the remainder are headed in the other.

Traffic Operations. Some potential conflicts were observed on this section of roadway during the field review. Also, from the Engineer's perspective during subjective evaluations at the site, it was noted that several factors have combined to create potential problems at this site.

1. The pavement surface is in poor condition. On the approach to the curve and within the curve, the pavement has a washboard texture that causes complete loss of vehicle control at

speeds greater than 35 mph. Safe speed on the curve itself is only 25 mph according to a Ballbank reading.

2. Vegetation along the roadside completely blocks the view of numerous approaches along the road. Vertical curves also restrict sight distance to vehicles using the drive approaches.

3. The steep grade on the approach to Highway 35 is especially troublesome for cars turning from Highway 35. There are no turn lanes on Highway 35 and the speeds are high. Exit speeds at the turn also tend to be high. The 9% down grade, after the turn, puts the motorist in a severe dilemma if some condition warrants a stop.

4. The 90 degree turn and existing road approaches has many more conflict points than any driver should be expected to encounter. Southbound traffic's problems are intensified because of the blind vertical curve preceding the horizontal turn.

Accidents. The collision diagram and accident statistics tables shown on the existing condition sketch indicates that there were four accidents recorded in the four year study period. The majority of accidents are single vehicle accidents, one of which was related to loss of control at the end of the 90 degree turn. The remaining accident, involved a collision with a parked car at the beginning of the study site, near Highway 35. Most of the accidents occurred on dry roads in fair weather conditions. The lighting conditions were primarily dark night time conditions. The severity of accidents at this site is slightly high with 50% of the accidents producing injuries.

SHORT TERM IMPROVEMENTS

Suggested improvements at this site strive to reduce the effects of the above noted problems. Over sized curve warning signs are considered necessary to draw more attention in advance of the 90 degree turn. Use of the advisory speed plates is critical to properly warn motorists of the conditions to be encountered. Limited sight distance signs are necessary to warn driver to adjust their speed and to draw attention to unusual conditions that could occur ahead.

Realignment of the approach in the turn area is absolutely necessary to properly delineate the curve and to eliminate the high number of conflict points in this area. Chevron signs recommended for delineation in this area require proper spacing to be effective. This recommendation also includes a pavement overlay of the curve, which is currently in extremely poor shape. It would be advisable to actually pave the entire section of roadway. If the counties annual budget allows for overlay projects, this site would be one of the county's top priority areas.

Clearing the right-of-way of trees and brush is also a critical action which must be taken to improve sight distance.

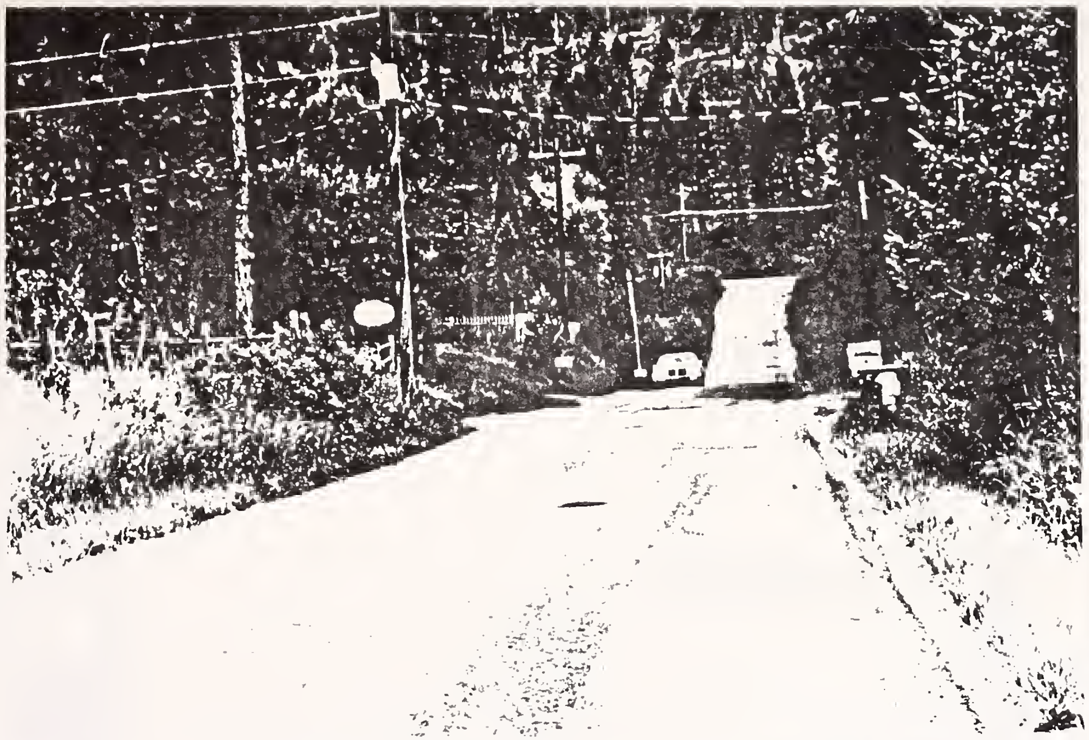
The cost of these improvements is estimated to be approximately $11,980 based on 1989 unit bid contract prices and MDOH fund eligible prices. The grading, paving and pavement markings should be much less if county crews performed the work

and the striping were to be completed as part of a county wide pavement marking program.

Long term improvements at this site cannot be foreseen nor should they be anticipated until traffic volumes increase beyond 4,000 ADT.

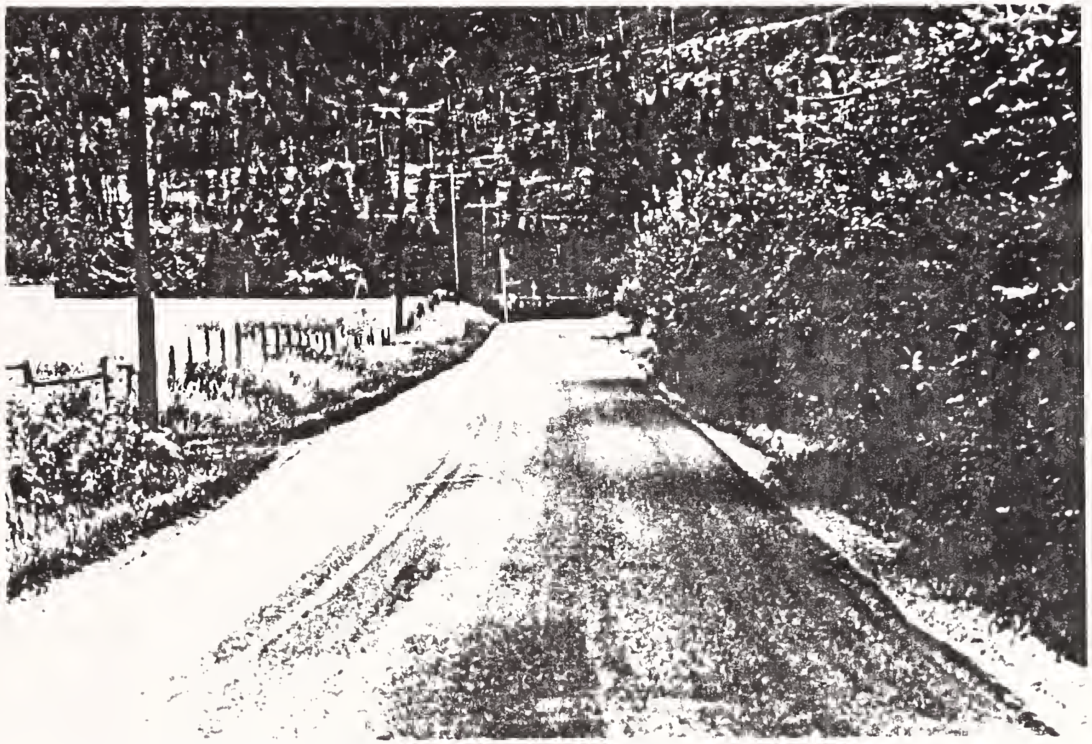
BENEFITS

The annual dollar benefit that may be realized from the short term improvements is computed to be approximately $5,714 annually. The benefit/cost ratio is computed according to accepted methods at 1.75.



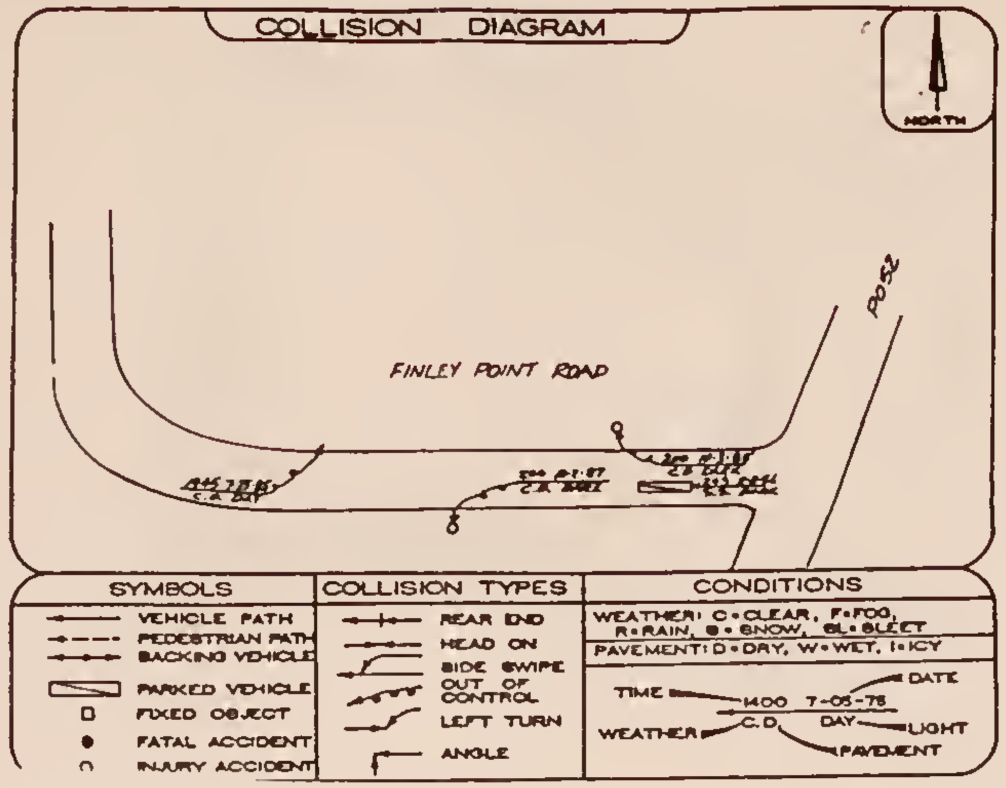
FINLEY POINT RD @ .2 MILE, EASTBOUND

FINLEY POINT RD @ HWY 35, WESTBOUND



FINLEY POINT RD @.4 MILE, EASTBOUND

FINLEY POINT RD @.2 MILE, WESTBOUND



ACCIDENT STATISTICS - FINLEY POINT ROAD

ACCIDENTS / YEAR :
1985 = 2
1986 = 1
1987 = 1
1988 = 0 TOTAL = 4

ACCIDENT TYPE - % OF TOTAL :

0	HEAD ON =	0%
0	ANGLE =	0%
0	LEFT TURN=	0%
0	SIDE SWP.=	0%
0	REAR END =	0%
3	SINGLE V =	75%
1	OTHER =	25%

WEATHER CONDITIONS - % OF TOTAL :

3	CLEAR =	75%
0	RAIN =	0%
1	SNOW =	25%
0	FOG =	0%

ROAD CONDITIONS - % OF TOTAL :

3	DRY =	75%
0	WET =	0%
1	ICY =	25%

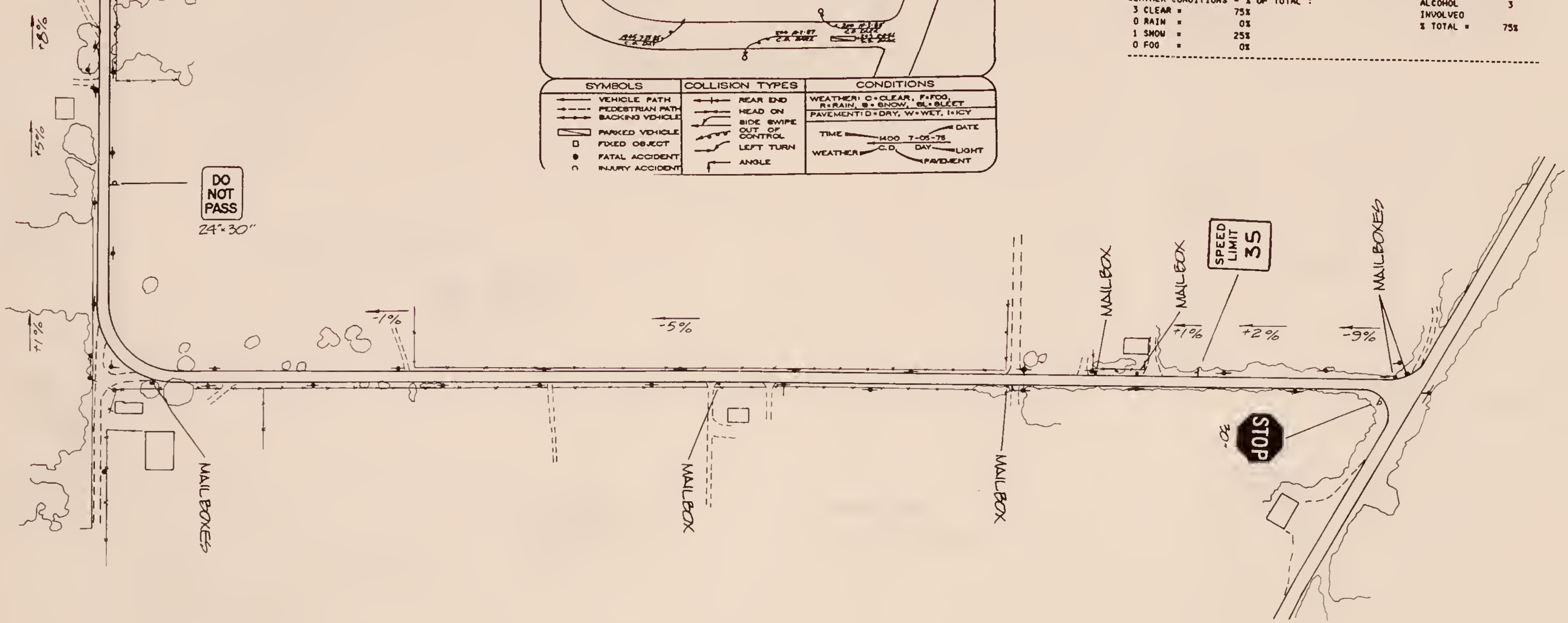
LIGHT CONDITIONS - % OF TOTAL :

3	DARK =	75%
1	DAY =	25%

SEVERITY - % OF TOTAL :

0	FATAL =	0%
2	INJURY =	50%
2	PROP DAM=	50%

ALCOHOL INVOLVED 3
% TOTAL = 75%



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Project: LAKE COUNTY TRAFFIC SAFETY STUDY

Sheet Title: FINLEY POINT ROAD EXISTING CONDITIONS

Surveyed By:
Designed By
Drawn By
Checked By
Date

Revisions
No. ___ Date ___
No. ___ Date ___
No. ___ Date ___
No. ___ Date ___

Project No.
Client No.

Sheet No. 1 of ___

SHORT TERM IMPROVEMENTS

ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : FINLEY POINT ROAD

ACCIDENT TYPE	# ACC. IN PERIOD I/F	# ACC. IN PERIOD PD	EST. % CHANGE	CHANGE IN # ACC. I/F	CHANGE IN # ACC. PD
HEAD ON	0	0	0%	0.0	0.0
ANGLE	0	0	0%	0.0	0.0
LEFT TURN	0	0	0%	0.0	0.0
SIDE SWIPE	0	0	0%	0.0	0.0
REAR END	0	0	0%	0.0	0.0
SINGLE VEHICLE	2	1	30%	0.6	0.3
PEDESTRIAN	0	0	0%	0.0	0.0
OTHER	0	1	30%	0.0	0.3
TOTALS :	2	2	***	0.6	0.6

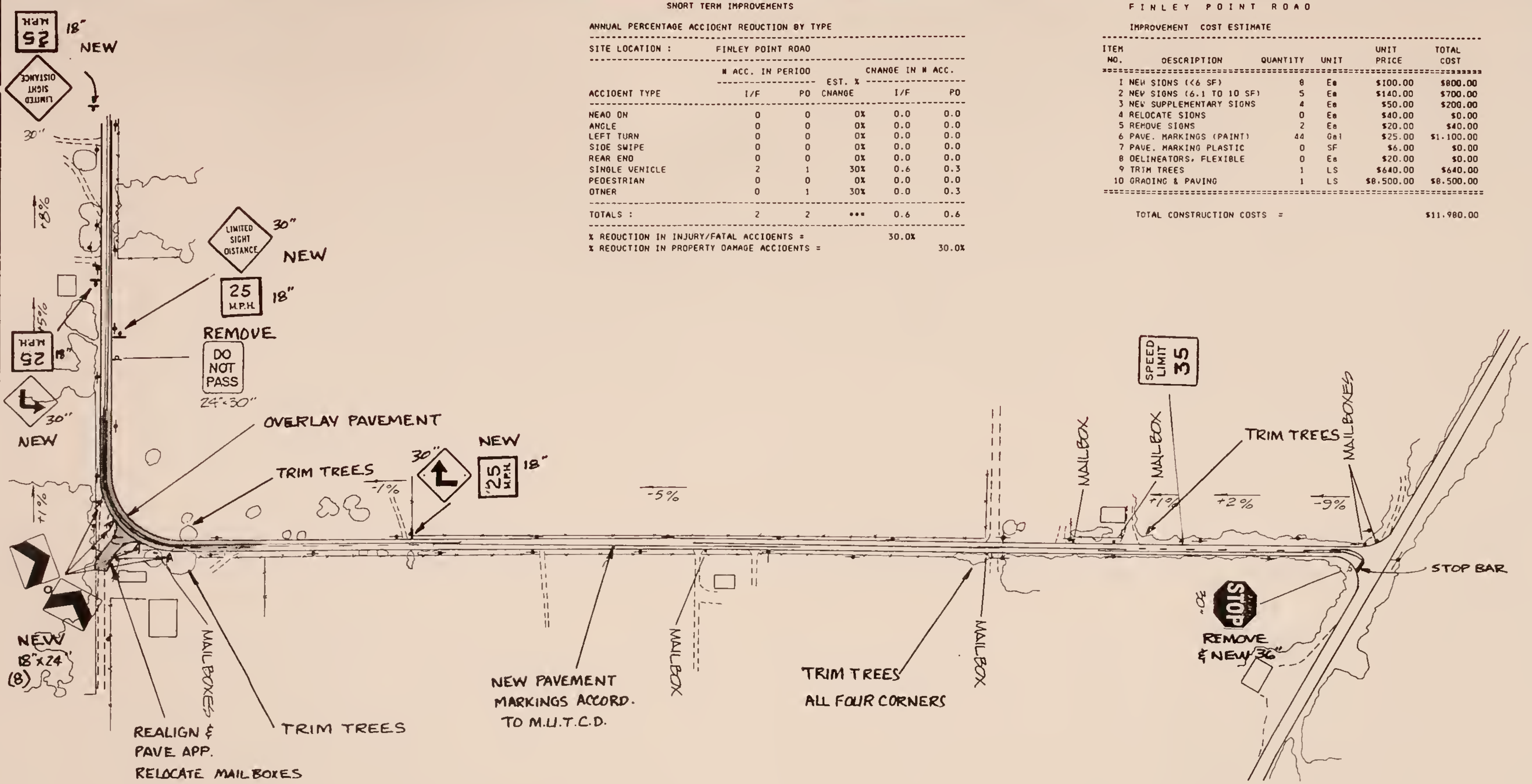
% REDUCTION IN INJURY/FATAL ACCIDENTS = 30.0%
% REDUCTION IN PROPERTY DAMAGE ACCIDENTS = 30.0%

FINLEY POINT ROAD

IMPROVEMENT COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	NEW SIGNS (<6 SF)	8	Ea	$100.00	$800.00
2	NEW SIGNS (6.1 TO 10 SF)	5	Ea	$140.00	$700.00
3	NEW SUPPLEMENTARY SIGNS	4	Ea	$50.00	$200.00
4	RELOCATE SIGNS	0	Ea	$40.00	$0.00
5	REMOVE SIGNS	2	Ea	$20.00	$40.00
6	PAVE. MARKINGS (PAINT)	44	Gal	$25.00	$1,100.00
7	PAVE. MARKING PLASTIC	0	SF	$6.00	$0.00
8	DELINEATORS, FLEXIBLE	0	Ea	$20.00	$0.00
9	TRIM TREES	1	LS	$640.00	$640.00
10	GRADING & PAVING	1	LS	$8,500.00	$8,500.00

TOTAL CONSTRUCTION COSTS = $11,980.00



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Project: LAKE COUNTY TRAFFIC SAFETY STUDY

Sheet Title: FINLEY POINT ROAD SHORT TERM IMPROVEMENTS

Surveyed By: ______
Designed By: ______
Drawn By: ______
Checked By: ______
Date ______

Revisions
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